NEW MEXICO

ENERGY CONSERVATION CODE

APPLICATIONS MANUAL

RESIDENTIAL BUILDINGS

Updated By

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This 1993 Edition succeeds all previous editions of the Energy Conservation Code Applications Manual and provides for the changes embodied in the Uniform Building Code, 1991 Edition and the Model Energy Code.

This manual can be provided in various accessible forms. Please contact the Energy Conservation and Management Division ADA Compliance Officer at 505-827-5907 or by the TDD phone at 505-827-5970 or by writing to the New Mexico Energy, Minerals and Natural Resources Department, 2040 South Pacheco Street, Santa Fe, New Mexico 87505, if a summary or other type of accessible form is needed.

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FOREWORD

This Applications Manual was prepared to assist the New Mexico building industry in the implementation of the Model Energy Code. As of this printing, the 1989 Edition was adopted on July 1, 1993, and the 1992 Edition is up for adoption by the State of New Mexico Construction Industries Division. The purpose of the Manual is to provide general information on energy and its use in residential buildings as well as how to apply the Model Energy Code during design to comply with the Code. This Manual is not intended to present every aspect of residential energy use or guarantee code compliance or good design. It does not preclude the designer from applying creativity and knowledge to develop complying designs which are unique. The purpose of the Examples section is to show how residential structures may be designed and meet the Code.

In conjunction with this update to the Manual, training sessions are being held for contractors, code officials, architects, and engineers to cover changes and updates to the Code. This update and the training sessions were funded by the Federal Energy Conservation Program and administered by the State of New Mexico Energy, Minerals and Natural Resources Department (EMNRD). Project Manager, Harold Trujillo, P.E., supported the Manual update and the training sessions. Mr. Robert Unthank, Mr. Fred Nevarez of the New Mexico Construction Industries Division, Mr. Mike Weix of the City of Albuquerque Code Administration Division, Mr. Jack Milarch, Jr. of the N.M. Homebuilders Association, Mr. Robert L. Kord of the El Paso Electric Company, and Mr. John Olmsted of the Public Service Company also provided assistance. As a living document, this manual has been updated several times. Through the years many other editors have contributed to this document and we acknowledge them.

While energy costs in the mid-1980's have stabilized and decreased, they are still substantially higher than costs prior to the 1973 oil embargo. Conventional energy sources are limited, and it is important that we, as designers and constructors of the built environment, recognize the economic, social, and political importance of energy in our work.

H. John Baumgartel, PE
Santa Fe, NM
December 1, 1993

INTRODUCTION

INTRODUCTION

All of us were made painfully aware of the rapid spiral of energy costs in the late 1970's and early 1980's punctuated by shortages of petroleum products brought about by the 1973 oil embargo. But the oil embargo only focused our attention on a more general problem. We were treating limited energy resources as if they were limitless. Although energy costs have stabilized and decreased recently, the lessons from the recent past must be heeded. We must work at conserving energy and improving efficiency - not just because the resources are limited, but also to reduce costs and improve our national security. Our built environment needs to be efficient during design and construction as well as throughout its operating life.

The building industry finds energy cost impacts reflected in the price of materials, labor, and operations. When the builder markets his product, whether in the commercial or the private residential sector, he is again reminded of energy costs. Businesses and home buyers are now energy cost conscious. Energy conservation, once a national interest issue, is now a very real pocketbook issue. Analyzing the costs of a building over its lifetime instead of just the first cost results in a more accurate cost of ownership. This Life Cycle Cost concept is beginning and will continue into the future.

Of the total energy consumed in a typical New Mexico home 57.5% was consumed for heating and air conditioning, 24.2% for water heating, 3.6% for lighting, 6.4% for refrigeration and 8.3% for cooking. Studies show much of this energy is currently wasted and contributes nothing to meeting these needs.

Our buildings represent mankind's attempt to provide a survival environment. In the face of past and future possibly dramatic changes in the availability and cost of fuels, better buildings which conserve our resources and reduce their cost will mean better human health, comfort, and economy.

THE HISTORY OF BUILDING CODES

Building codes have served traditionally to protect the safety and health of building occupants and the community. They have existed in cities for nearly four thousand years with the earliest known example being found in the Code of Hammurabi about 1750 BC. The earliest codes were specification codes which defined what materials and methods of construction were acceptable; that type of code has existed to the present. In contrast, a newer invention, that of the performance code, defines the desired end result but does not specify the means of achieving that result. The performance code permits use of new materials and designs as they become available and are found acceptable. Such provisions are essential for an expanding technology and must be included to enable use of improved materials and methods.

Building codes usually apply to new structures and traditionally have not governed structures erected prior to enactment of the codes. Only when existing structures are renovated have they been required to conform to current building codes.

Fire codes have existed for the purpose of controlling community or occupant safety or limitation of property damage. They must be complied with during construction and also during the life of the structure.

Contrasting with codes, other controls have existed through limitation of the availability or cost of mortgage money for structures which do not meet minimum requirements. Historically, the control of energy efficiency of structures has not been part of the restrictions of building codes; rather, the responsibility of codes has been safety. Energy standards are a recent concept due to the limitations of energy availability.

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 90.1-1989 is a comprehensive component-performance document that regulates building energy used for heating, ventilation, air conditioning, lighting, service water heating, and electrical power distribution. With respect to building envelopes, it is based on calculations of steady-state conditions with empirical adjustment for air leakage, solar factor as influenced by latitude, and shading coefficient of the fenestration. For cooling only, the mass of wall construction is considered. ASHRAE Standard 90.1-1989 is a revision of the original Standard 90-75 and its successor 90A-1980.

The publication of the ASHRAE Standard 90-75 provided the basis for energy conservation requirements in many building codes. The 1992 Model Energy Code (referred to as the Code in this Manual) developed by the Council of American Building Officials (CABO) has requirements based on this standard and its successors.

THE NEW MEXICO STORY

New Mexico has been a leader in the conservation of energy in new buildings. The decision to incorporate the Uniform Building Code Appendix Chapter 53, Energy Conservation into the New Mexico Uniform Building Code was made in September, 1976. After training materials were developed, workshops were held throughout the state in the summer and fall of 1977. Hundreds of persons from all aspects of the building industry learned about Chapter 53 prior to implementation in November, 1977.

The Construction Industries Committee adopted the Uniform Building Code, 1979 Edition, in April 1980 with an effective date of April 15, 1980. Appendix Chapter 53 was included in this adoption also. The 1979 Appendix Chapter 53 was changed from the 1976 Edition. Both of these Energy Conservation Codes were based on ASHRAE 90-75 so they were much the same, but there were differences. For example, the prescribed interior winter design temperature was raised from 70 deg. F to 72 deg. F. Probably the most significant change was the inclusion of Section 6, Design by Acceptable Practice. This procedure eliminated the need for cumbersome heat loss calculations for most residential construction and many smaller commercial construction projects. The standards did not change, only the method of demonstrating compliance.

Another major difference between the Codes was in the electrical section. The new Code required that a Lighting Power Budget be calculated on all commercial projects. This requirement was modified in New Mexico to include recommended footcandle levels for various spaces.

There was one other New Mexico modification to the Code. In research done at the University of New Mexico, it was shown that laboratory measurements of heat transfer through building materials often did not reflect accurately the way those same materials behave when part of a real building under the New Mexico sun. This led to the creation of what are called "Effective U-Values." The Construction Industries Committee allowed these Effective U-Values to be used in certain Code-required heat loss calculations. The original table of Effective U-Values has been added to over the years and was completely revised in 1981.

In 1986, the General Construction Bureau of the Construction Industries Division adopted the Uniform Building Code, 1985 Edition with certain changes and exceptions. Appendix Chapter 53 stated that Chapter 53 requirements would be complied with through use of the Model Energy Code (MEC). New Mexico adopted the 1983 Edition which was automatically superseded by the 1986 Edition of the MEC. Additionally, the requirements of Section 505 and 605 on Electrical Power and Lighting were excluded. The use of Effective U-Values was not considered in the Model Energy Code, but information is presented on Effective U-Values in the section on Passive Solar Applications as it is recognized as a unique and useful tool in calculating energy use in New Mexico.

The Construction Industries Commission adopted the 1989 Model Energy Code on June 25, 1993 and later extended the effective date to July 1, 1993. The significant aspect of this adoption was that the requirements of Sections 505 and 605 regarding electrical power were included, instead of being excluded as they had been in the past. The National Energy Act directs states to adopt the 1992 Edition.

SCOPE AND PURPOSE

The basic purpose of this Manual is threefold:

1. **An educational tool.** The following section on Energy Fundamentals is presented as an overview of how buildings use energy and how that use can be controlled by decisions made during the design and construction phases.

2. **An analysis and update of the current New Mexico Energy Code.** Since the last Applications Manual prepared in 1988, the Model Energy Code has been adopted, implemented, and updated. In the third section of the Manual, the MEC is summarized, changes from the previous versions are discussed, and New Mexico design conditions are presented.

3. **A guideline for Energy Code compliance.** Compliance paths are presented covering certification, plans and specifications, details, and inspections. Alternate compliance paths are covered. Finally, specific examples for analyzing typical designs are shown in Section VII.

   The method of compliance for residential structures in New Mexico is the "Model Energy Code, Thermal Envelope Compliance Guide, January 1992." This method of compliance will be explained and the various tools and procedures presented.

Additionally, a passive solar design methodology is presented along with information on Effective U-Values. Currently, Effective U-Values are not part of the New Mexico Energy Code, however their value as an appropriate design tool has been widely recognized. If the designer wishes to use Effective U-values in calculations, a check with the local code officials is necessary to assure acceptance for demonstrating compliance.

A copy of the Thermal Envelope Compliance Guide and blank calculation forms are provided with the Manual. These forms may be reproduced as required. Their use will formalize the required calculations and help demonstrate compliance.

It should be understood that the New Mexico Energy Code is law. Its use is required as part of the New Mexico Building Code. The purpose is not to be a burden to the construction industry but to help assure that our built environment is energy efficient and economical.

ENERGY FUNDAMENTALS

HEAT ENERGY

Energy is defined as the capacity to do work; the rate of energy usage is power. There are many forms of energy; energy of motion, or mechanical energy, is a most familiar active form. Energy usually is converted from one form to another when it is put to use. Combustion is an example of the chemical energy in a substance being transformed into heat energy through the change in the molecular structure of the substance when it combines with oxygen.

The annual energy requirements of a building constitute the total amount of energy used by that building each year to maintain a selected inside environment under the condition of a year's climate and to supply required lighting, hot water, and power for equipment and appliances. Energy requirements include fossil fuels consumed in the building as well as the fossil fuels needed to generate and deliver electricity used for comfort conditioning, lighting, and power.

Heating and cooling usually constitute the single largest block of energy consumed in a building. Cooling occurs when energy is removed from a building, usually through mechanical refrigeration equipment. Heating occurs when energy is added by heating systems such as gas and electric furnaces or heat pumps. To understand how much energy must be removed from or added to a building, and how to size equipment required to maintain comfort conditions, one first must understand how energy is measured, and how it moves in its various forms.

Measuring Heat

The intensity of energy within an object or substance is measured by its temperature. In this country, temperature is usually expressed in degrees Fahrenheit (deg. F). The intensity of energy should not be confused with quantity of heat. Thermodynamically, heat is defined as the form of energy that is transferred across a boundary from one object to another object at a lower temperature.

The basic unit used in this country to measure quantity of heat is the British Thermal Unit or Btu. A Btu is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit from 59.5 deg. F to 60.5 deg. F at sea level. All forms of energy can be expressed in Btus. The following list shows several approximate relationships.

Substance	Amount	Btus (Approximate)
Natural Gas	1 cubic foot	1,000
No. 6 Fuel Oil	1 gallon	146,000
Propane	1 gallon	92,000
Butane	1 gallon	103,000
Coal	1 pound	13,000
Wood	1 pound	7,600
Gasoline	1 gallon	125,000
Electricity	1 kWhr	3,413
Solar Energy on	1 square foot/day	1,800

Another measurement-related term is the degree day. Degree days were developed by fuel oil supply companies to predict based on weather the date for the next refilling of a heating fuel tank. The degree day is normally measured from a base of 65 deg. F on the temperature scale. If, in a particular location, the average temperature for a 24-hour period were 60 deg. F, then 60 would be subtracted from 65 and that particular place would have five degree days for the period. In this case, they would be Heating Degree Days (HDD) implying heating is required to maintain comfort. Cooling Degree Days (CDD) can also be calculated in a like manner. When records of degree days are compiled and summed for a one-year period, the resulting annual degree days provide a basis for determining heating and/or cooling needs for a particular location.

In the extreme north central United States, some locations have more than 10,000 HDD. In New Mexico, the range is from about 2,500 HDD to over 9,000 HDD. Heating Degree Days are listed for certain cities in the Table in Appendix B.

HEAT TRANSFER

In the study of thermodynamics, heat is defined as energy crossing a boundary, or transferring from regions of higher temperature to regions of lower temperature. Heat will move either into or out of a building depending on whether the temperature in the building is lower or higher than the outside temperature. Although there are ways to slow down the rate of heat energy movement, it is important to note that nothing stops the movement. If there is no difference between outdoor and indoor temperatures, then theoretically there is no energy or heat transfer. Heat is transferred by three basic processes: conduction, convection, and radiation.

Conduction

Conduction can be thought of as the transfer of energy from one molecule to another resulting from a difference in temperature. As the temperature increases the molecules vibrate faster, colliding with and causing adjacent molecules to vibrate. In this manner, heat energy is transferred from one portion of a body to another or between two objects having different temperatures.

The rate of transfer determines the effectiveness of the material as conductor. By building walls of materials with known qualities of conduction, the builder can control the heat transfer rate through that wall.

Convection

Convection is the transfer of heat by fluid movement, either as liquid or as gas. When heat is transferred by the process of convection it has been transported or moved from one place to another by being carried in a fluid. Convection can be natural, due to the difference in densities of warmer and cooler fluids, or forced as by pumps or blown by a fan. Usually the fluid is air or water in building construction, because they are inexpensive and relatively available. Most heating systems use convection processes to move heat from one place to another in a building.

Radiation

Radiation is the transfer of heat from an object by electromagnetic waves. For radiant heat transfer, internal energy at the source is transformed to electromagnetic energy for transmission and then back to internal energy at the cooler receiver. In this manner, the heat transfer is between separate objects, and the air in between is not heated. These electromagnetic waves are similar to those which transfer radio and television signals. These waves are known as infrared, or heat waves, and have a prescribed wavelength range. All warm objects give off heat by radiation to cooler objects.

The higher the temperature of a body, the greater is the amount of heat energy radiated from that body. The sun is one body that transfers its heat energy by the radiation process. The earth receives a small portion of this radiation. From this source comes all of the earth's energy potential except for nuclear and fusion energy.

R-VALUES AND U-VALUES

R-values and U-values are the basic concepts essential to an analysis of the thermal performance of a building component such as a wall or ceiling. Simply put, a U-value is a measurement of how well a specific building material conducts heat. The ability of different materials to conduct heat varies considerably. The best conductors of heat are usually dense materials, for example, a steel or aluminum window frame.

Thermal resistance is the opposite of conductance and is a measure of a material's ability to retard heat transfer. This is commonly expressed as an R-value. The R-value number merely indicates the relative ability of a specific material to resist heat transfer. The higher the R-value number, the higher the insulating quality. Poor conductors of heat such as wood, cork, or felt are insulators and have relatively high R-values compared to metals such as aluminum or copper.

R-values and U-values share a reciprocal relationship; that is the product of a material's U-value and R-value is one (1). This relationship is expressed simply as:

$$\mathbf{R \times U = 1} \text{ so that } \mathbf{R = 1/U} \text{ and } \mathbf{U = 1/R}$$

Typical units used throughout this Manual are:

R-value = hr-sf-deg.F/Btu U-value = Btu/hr-sf-deg.F

Determining the overall U-value (U_o) of a building component, such as a wall, requires consideration of all the materials in the building component as well as any air spaces and surface air films that are a part of the building component. The determination is made as follows:

1. The R-values are listed (in the Appendices of this Manual, for example) for all the various parts of the building component.

2. The individual R-values of materials in series are added to get a total R, or R_t:

$$R_1 + R_2 + R_3 + = R_t$$

3. Since U and R are reciprocals, then 1 is divided by R_t to get the U_o-value for each building component.

This is explained in more detail in Section VII on Examples.

It is important to point out that most insulating materials, materials with high R-values, are not good insulators in and of themselves. They depend upon trapped air within their construction for their insulating qualities. For example, single glass has a winter U-value of 1.10, while two inches of fiber glass (the same material arranged differently) have a U-value of approximately 0.14. This large difference is due to the air trapped within the matrix of fine glass fibers.

BUILDING HEAT LOSS

The Code provides specific regulation of building heat loss and gain through both the conduction and convection processes. These are covered in more detail here.

Conduction

The conduction of heat through building envelope components (walls, floors, roof/ceiling) is usually assumed to be at a constant rate, or steady state, and is based upon a specific temperature difference between indoor and outdoor temperature. The amount or quantity of heat loss by conduction (Q) through the building envelope depends on three factors:

1. The combined heat conducting properties of the materials in the building envelope element (U-value),

2. The surface area of the element through which heat is conducted (expressed in square feet - SF), and

3. The temperature difference between conditioned space and unconditioned space. (Temperature inside minus temperature outside - dT, which is expressed in degrees Fahrenheit or deg. F.)

The formula which expresses this relationship is:

$$Q = U \times Area \times dT$$

The total building conduction heat loss is determined by adding the heat loss through each building component, i.e., roof/ceiling, walls, floors, doors, and windows.

From this formula we can make several observations. If the area of a building component is increased, the heat gain/loss will also increase. This item is not subject to much control. We also observe that the greater the temperature difference between inside and outside, the greater the heat gain/loss. This item is also not subject to great control.

It follows that if the heat conduction properties of the building envelope can be controlled, then the amount of heat gain/loss due to conduction can be controlled. This is the mechanism used in the code to regulate energy consumption. Maximum U-values allowed by the Code are established for various temperature differences (climate zones) and building components.

Convection (Infiltration)

The second major cause of heat loss/gain in a building occurs due to unconditioned air being carried into the conditioned space, and conditioned air being carried out of the conditioned space. Energy is required to condition (warm or cool) this introduced unconditioned air. In the interest of energy conservation in buildings, it is desirable to control this factor, and the Code specifies how that is done.

Infiltration -- and exfiltration -- occurs due to cracks and other openings in the building envelope. Sometimes the potential for infiltration is due to lack of care in construction and inattention to details. Even small cracks around window sashes, window frames, doors, door frames, electrical outlets, or any other opening in the envelope, permit a surprisingly large amount of air to enter or leave the conditioned space. It should be pointed out that some infiltration is desirable as a source of fresh air. With recent concerns about radon, for example, a minimum amount of infiltration is beneficial. However, the amount should be controlled by the design and construction.

The two main forces creating infiltration are wind pressure and thermal movements. Wind pressure simply pushes unconditioned air into the conditioned space through any available opening in the building envelope. A negative pressure on the other side of the building draws conditioned air out of the conditioned space and compounds the losses. Thermal movements cause heat loss/gain by natural convection within the conditioned space such as occurs when heated air rises up a fireplace chimney around a poorly fitted damper. Whenever conditioned air is used to support combustion processes, such as in a water heater or furnace, other large losses occur.

Convection (Film Coefficients)

The heat transfer from the building envelope surfaces to the outside air is governed by the film coefficient of the surface. A film coefficient is the resistance to the flow of heat existing at the boundary between air an solid (or liquid). This film coefficient is a function of surface material, texture, wind velocity, and orientation. Values of film coefficients are listed in the R-Values of Materials Table in Appendix C.

HOW BUILDINGS USE ENERGY

Buildings use energy for two basic reasons to maintain an environment for people and machines and to provide power for equipment. Specific areas of energy use are:

1. Heating
2. Cooling
3. Lighting
4. Domestic Hot Water
5. Power for Equipment/Appliances

The amount of energy use by each category depends on environment, building function, construction and operation. Buildings with large internal loads such as people, lights, and equipment, require little or no heating even in the winter. Enough heat is generated inside the buildings and usually there is much more internal floor space compared to perimeter space so that cooling is needed all the time. These buildings are referred to as internal load dominated buildings. Examples are hospitals, large office buildings, and factories.

Other buildings are referred to as shell, envelope or skin dominated. This means that their energy use more directly follows the weather. When it is cold outside, heating is required, and when it is hot, cooling is needed. Houses and small commercial structures are usually skin dominated.

Normally, heating, cooling and lighting are the areas of largest energy use, although in schools and hospitals, domestic hot water use can be quite large. Therefore, the size, function, and layout of a building need to be examined to accurately determine how most of the energy will be used. With respect to energy conservation, knowing how most of the energy is used helps focus on where the largest opportunities for savings are. This is most important in designing energy-conserving retrofits for buildings -- the Code specifies minimum conservation levels for new construction. However, a thorough design analysis can often uncover additional savings potential if it is understood how a particular building uses energy.

Energy use in buildings is not just a matter of saving Btus. Energy costs of buildings can run $2.00 or more per square foot per year depending on use, hours of occupancy, construction, etc. A 10,000 square foot office could require $15,000 for energy per year. A 10% savings would result in $1,500 per year. If additional energy-conserving features can be designed which cost, say $8,000 and reduce use by 10%, the simple payback is $8,000/$1,500 per year = 5.3 years. While the Code specifies minimum conservation levels, opportunities usually exist for additional cost-effective design beyond these levels.

HUMAN COMFORT

Building comfort conditioning is a process in which environmental factors of a given space are controlled to provide occupants with some degree of physical comfort. Like any other machine, the human body works best at certain temperatures. It is only within a small range of about 20 deg. F (from 65 deg. F to 85 deg. F) that most people feel comfortable. Several factors which affect human comfort are described below.

1. **Temperature** - A lower surrounding air temperature speeds the rate of convection, because it draws more heat from the body. As the temperature of the surrounding air rises, the rate of convection heat loss is reduced. As the temperatures of the surrounding surfaces approach skin temperature, the radiative heat loss drops. With greater increases of surrounding surface temperature, the radiation process is reversed and heat flows from the surface to the body. Therefore, the body has to give off even more heat through convection and evaporation if it is to remain comfortable.

2. **Relative Humidity** - Relative humidity is a term used to measure the amount of moisture in a given sample of air in comparison to the amount of moisture the air would hold if totally saturated at the temperature of the sample. Relative humidity is referred to as a percentage, such as 40%, 50%, etc. The relative humidity of the air affects the rate of evaporation. The more moisture there is in the air, the less capacity there is to absorb the moisture given off by the body. Recommended relative humidity limits are between 20% and 60%.

3. **Air Motion** - The motion of air also affects comfort. If cool dry air is circulated past a warm body, the evaporation rate increases greatly as does the convection rate. During a heating season, a lack of air movement can tend to cause the indoor air to stratify; the cooler air will remain close to the floor and the warmer air will rise to the ceiling. If stratification in a room can be reduced, less energy will be required to maintain a comfortable temperature level.

4. **Air Purity** - Air purity is another factor influencing comfort. Typical pollution includes smoke, smog, dust, and dirt. Levels of these increase in "tight" buildings with reduced outside air quantities. These pollution particles can create discomfort to the nose, throat, and eyes and can eventually lead to long-term health problems.

5. **Noise** - Noise can be an important factor affecting comfort, especially when the space involved is used for work or other activities which require concentration. In a well-insulated space, transmission of noise from outside sources is greatly reduced.

6. **Type of Activity** - The type of activity performed in an area relates to comfort. A person sitting quietly requires a higher surrounding temperature for comfort than someone engaging in physical activity.

7. **Personal Characteristics of Occupants** - These factors are important in terms of their deviation from what is loosely termed "normal." Older persons, for example, usually require higher temperatures for comfort; certain persons are far more bothered by dust, pollen, and other airborne particles than others, and so on.

CODE FOR ENERGY CONSERVATION

OVERVIEW

The energy code currently in force in New Mexico is per Appendix Chapter 53 of the Uniform Building Code, 1991 Edition which states that the Model Energy Code, 1989 Edition is adopted. The National Energy Act directs states to adopt the 1992 Model Energy Code (MEC).

It should be noted that Sections 505 and 605 of the MEC on Electrical Power and Lighting are now included in the New Mexico Building Code. These sections deal with development of a lighting power budget and determination of illumination levels. While not a major factor in residences, lighting in commercial structures can be quite significant. Not only does lighting require energy for illumination, but the more lighting, the larger the cooling load; a particular concern in internally load dominated buildings.

Brief Summary

The Model Energy Code is based on ASHRAE 90A-1980, Energy Conservation in New Building Design and its successor ASHRAE 90.1-1989. The Code contains general definitions of applicable terms, design conditions, design approaches, and appendices. (The specific design approaches are covered in the next section on Code Compliance.)

Basically, the Code sets minimum requirements for the design of new buildings by regulating the exterior envelopes and the selection of heating, ventilating, and air-conditioning (HVAC) equipment and service water equipment for the effective use of energy.

Certain buildings are exempt, specifically:

- Buildings and structures whose peak design use is less than 1.0 Watt per square foot of floor area, or
- Buildings and structures which are neither heated nor cooled.

With regard to existing buildings:

- Additions shall conform although the existing portion does not need to be brought up to the energy code.
- Historic buildings as designated by the State or local governing body are exempt.

- A change in occupancy or use of an existing building constructed under this code which results in an increase in energy use requires that the building be brought into compliance with the Code.

- In buildings of mixed occupancy, each portion shall conform to the requirements for the occupancy housed therein. If the mixed uses are less than 10 percent of the area of any floor, the major use shall be the occupancy type.

CHANGES APPEARING IN THE 1992 EDITION

The 1992 Edition is the current Model Energy Code Edition. The previous edition was the 1989 Edition. Changes between 1989 and 1992 are relatively few. Specific changes include:

Chapter 1: Scope and General Requirements

Adds an exemption from the Code for Buildings, other than one- and two -family dwelling three stories or less above grade, which comply with the provisions of Standard RS-24 except the 1992 standby loss values for Storage Water Heaters listed in table 11-1 of the Standard. The Standard RS-24 is "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings," ASHRAE/IES 90.1-1989.

Chapter 4: Building design by Systems Analysis and Design of Buildings Utilizing Nondepletable Energy Resources.

The 1992 edition expands the exemption from providing a full year analysis to all buildings with less than 5,000 sf. This exemption previously required that the heating system also had to be controlled from a single point.

Chapter 5: Component Performance Approach

The language is changed to allow the U_o, U, or R to be increased or decreased, instead of just the U values.

Calculation procedures are introduced to allow the heat capacity of building components to be employed in establishing compliance. Previously thermal mass was allowed to be considered, but no methodology was provided. The ability to employ thermal mass is helpful to the design of buildings in New Mexico because this allows the effects of solar gain and high day-to-night temperature swings to be used.

Language is added to require the addition of moisture barrier when intrusion of moisture resulting from increased insulation might cause damage.

The depth of slab perimeter insulation has been increased from 24 in. to 48 in. in areas with Heating Degree Days greater than 6000.

Crawlspace walls and Basement Walls: Requirements for thermal insulation have been added for these building elements.

Chapter 6: Building Design by Acceptable Practice

Language is added to require the addition of moisture barrier when intrusion of moisture resulting from increased insulation might cause damage.

Two additional charts have been included for use when determining compliance by glass percentage, glazing U-value, and Opaque wall U_o. The two new charts are for glazing U-values of 0.49 and 0.36.

The depth of slab perimeter insulation has been increased from 24 in. to 48 in. in areas with Heating Degree Days greater than 6000.

Crawlspace walls and Basement Walls: Requirement for thermal insulation have been added for these building elements.

Chapter 7: Standards

Added standards are:
ASHRAE Standard 62-1989 Ventilation for Acceptable Indoor Air Quality.
Standard Test Methods for Water Vapor Transmission of Materials, ASTM E96-80.
Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings, ASHRAE/IES 90.1-1989.

DESIGN CONDITIONS

A building that is designed to be both heated and cooled shall meet the more stringent requirements between heating or cooling whenever requirements in the Code differ. The design of buildings for energy conservation shall not create conditions that will lead to excessive moisture condensation and the damage it will cause.

New Mexico Design Conditions

For simplicity in determining allowable U-values, and in establishing acceptable practices, New Mexico has been divided into seven climate zones as shown on Figure 1. Each zone has fairly uniform winter and summer characteristics. Table 1 is a listing of the major population weather reporting stations within each area, from the coldest in Region 1 to the warmest in Region 7.

Design conditions for specific locations in New Mexico are shown in chart form in Table 2. These values were obtained from actual recorded weather data presented in New Mexico Climate Manual: Solar and Weather Data published by the New Mexico Research and Development Institute and from the ASHRAE Handbook of Fundamentals. This weather data is of importance to the designer, architect, contractor, engineer, plan checker, and building code official.

Winter and summer design conditions were selected from the 97-1/2% values for winter and the 2-1/2% values for summer. Adjustments should be made to reflect local variations in the climate or local weather experience as determined by the building official. Specific climatological data for New Mexico including HDD and CDD summaries are available from the National Oceanic and Atmospheric Administration (NOAA).

Indoor Design Conditions

Indoor design temperature shall be 72 deg.F for heating and 78 deg. F for cooling. Indoor design relative humidity for heating shall not exceed 30%. For cooling, the actual design relative humidity within the comfort envelope, as defined in ASHRAE Standard 55-1992 "Thermal Environmental Conditions for Human Occupancy" shall be selected for minimum total HVAC system energy use.

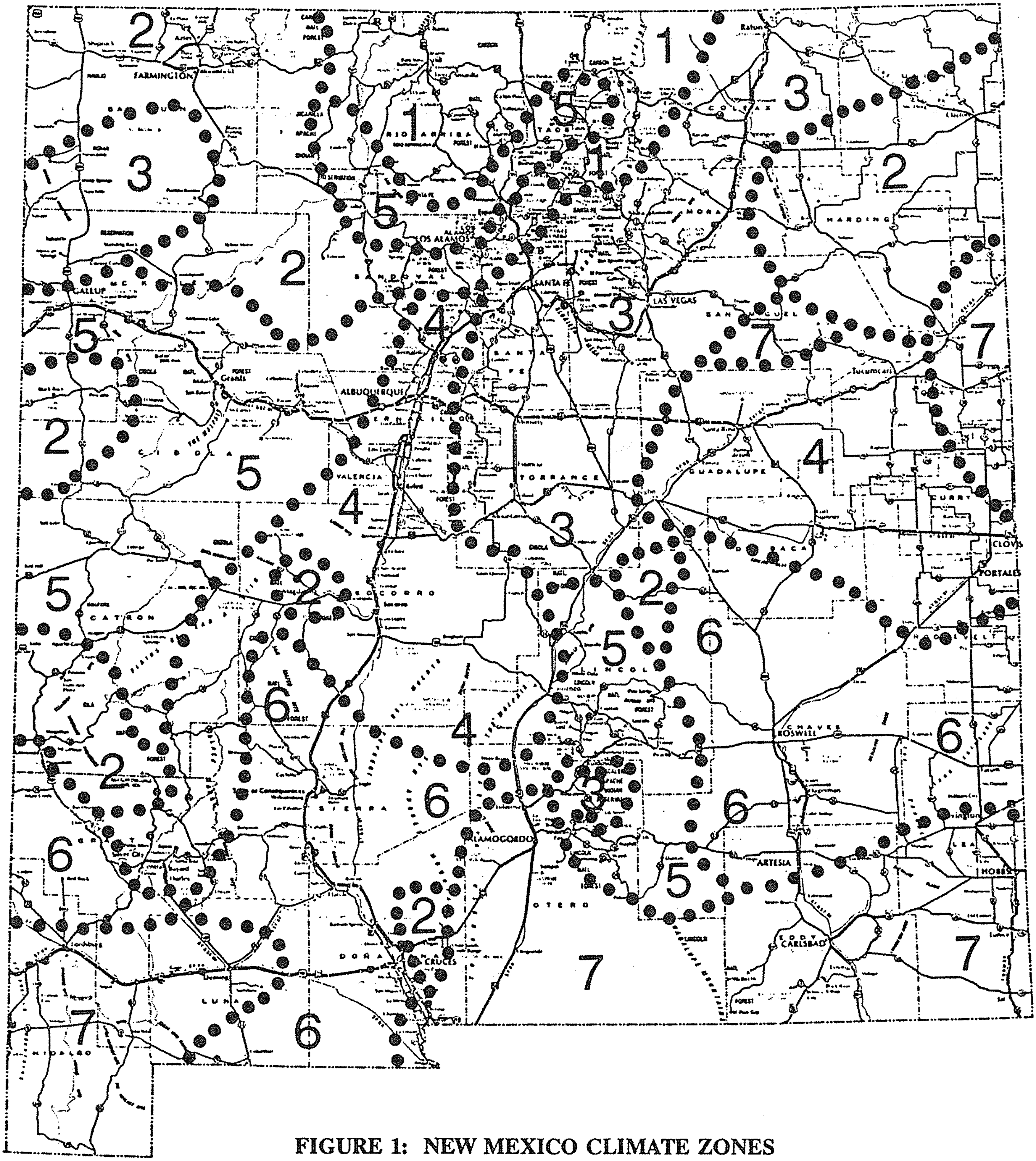


FIGURE 1: NEW MEXICO CLIMATE ZONES

TABLE 1: SELECTED CITIES BY CLIMATE ZONE

Climate Zone 1
- Chama
- Eagle Nest
- Questa
- Red River
- Tierra Amarilla

Climate Zone 2
- Aztec
- Bloomfield
- Clayton
- Crownpoint
- Espanola
- Farmington
- Jemez Springs
- Magdalena
- Reserve
- Shiprock
- Zuni

Climate Zone 3
- Cedar Crest
- Corona
- Estancia
- Las Vegas
- Mescalero
- Mora
- Moriarty
- Mountainair
- Pecos
- Raton
- Santa Fe
- Springer

Climate Zone 4
- Albuquerque
- Belen
- Bernalillo
- Carrizozo
- Clovis
- Fort Sumner
- Los Lunas
- Portales
- Rio Rancho
- Santa Rosa
- Socorro
- Silver City
- Tucumcari
- Vaughn

Climate Zone 5
- Cloudcroft
- Cuba
- Gallup
- Grants
- Los Alamos
- Ruidoso
- San Ysidro
- Taos

Climate Zone 6
- Artesia
- Glenwood
- Las Cruces
- Roswell
- Truth or Consequences

Climate Zone 7:
- Alamogordo
- Carlsbad
- Deming
- Hobbs
- Lordsburg
- Lovington
- Tularosa

TABLE 2: NEW MEXICO DESIGN CRITERIA

CITY	LATITUDE ° '	CLIMATE ZONE	WINTER DRY BULB F.	SUMMER DRY BULB F.	SUMMER WET BULB F.	HEATING DEGREE DAYS	COOLING DEGREE DAYS
Alamogordo	32 50	7	19	96	68	3053	1650
Albuquerque	35 00	4	16	94	65	4332	1300
Carlsbad	32 20	7	19	100	71	2813	2000
Chama	36 55	1	-4	82	55	8254	70
Clayton	36 27	2	5	92	62	5150	770
Clovis	34 30	4	13	93	68	4033	1250
Deming	32 16	7	18	99	64	3347	1690
Eagle Nest	36 33	1	-12	79	55	9254	14
Espanola	36 00	2	4	92	61	5641	N/A
Farmington	36 50	5	6	93	65	5747	750
Gallup	35 30	5	5	89	62	6207	450
Grants	35 10	5	4	88	62	6143	550
Hobbs	32 40	7	18	99	70	2954	1850
Las Cruces	32 20	6	20	96	68	3223	1600
Las Vegas	35 36	3	3	87	59	5738	280
Los Alamos	35 50	5	9	87	61	6381	350
Raton	36 50	3	1	89	64	6001	350
Reserve	33 43	2	5	92	58	5483	N/A
Roswell	33 20	6	18	98	70	3565	1550
Ruidoso	33 22	5	1	85	57	6309	120
Santa Fe	35 40	3	10	88	62	6001	400
Silver City	32 40	4	10	94	64	4438	650
Socorro	34 00	4	17	95	66	3984	1300
Taos	36 23	5	-4	87	58	6827	N/A
T or C	33 14	6	18	95	62	3394	1560
Tucumcari	35 10	4	13	97	69	3767	1350
Zuni	35 06	2	3	89	57	5742	480

CODE COMPLIANCE

INTRODUCTION

The Regulation and Licensing Department of the Construction Industries Division (CID) of the State of New Mexico has established Rules and Regulations regarding contractor licensing, permitting, plan review, and inspections. These rules and regulations are independent of the specific building code (or discipline) and deal with the authority to oversee the use and enforcement of all codes adopted by the CID. Provisions for permitting, plan review and inspections are also included in the New Mexico Building Code.

The current Rules and Regulations, CID-90-1 includes 3 amendments, and was adopted effective July 1, 1990. The 1991 New Mexico Building Code, CID-GCB-NMBC-91-1, has been in effective since July 1, 1993. Together these documents define and regulate the process of constructing a building.

Specific topics are covered in this section including how to comply with the Model Energy Code by one of three available compliance paths. However, nothing contained herein obligates any code official. As a designer or builder, it is in your best interest to contact the local building code official regarding any questions or concerns about compliance.

PERMIT REQUIREMENTS

General

A construction permit is required in order to construct, including remodel or renovate, all but a limited list of exempt structures. A permit must be obtained from a local building agency or from the CID. Application forms and requirements will vary with the regulatory agency.

In order to obtain a permit from CID, 2 sets of construction plans and specifications shall be submitted. The plans must be drawn to scale and shall be of sufficient clarity to indicate the location, nature, and extent of work proposed and show in detail that it will conform to the provisions of the code and all relevant laws, ordinances, rules and regulations. If there is insufficient information for a code official to check for conformance with the Code, the building official may require additional information reasonably necessary to show that the building or work will conform to the provisions of the Code.

Model Energy Code Compliance

The plans and specifications shall show in sufficient detail all pertinent data and features of the building and the equipment and systems. Depending on the requirements of the permit, required information may include but is not limited to: exterior envelope component materials, U-values of the respective elements including insulation, R-values of insulating materials, heat loss calculations, size and type of apparatus and equipment and system controls, and other pertinent data needed to indicate conformance with the requirements of the Code.

For a Residence, submit the Applications Worksheet and, when necessary, the Trade Off Worksheet.

When must Plans and Specifications be prepared by an Architect or Engineer ?

The 1991 New Mexico Building Code requires all plans and specifications be prepared and sealed by a Registered New Mexico Architect and/or Registered New Mexico Professional Engineer for all uses as listed in Table 33-A of the Uniform Building Code, with the exception of those listed in Section 302 (b) of the NMBC. The exceptions include:

1. single-family dwelling not more than two (2) stories in height.
2. multiple dwellings not more than two (2) stories in height containing not more than 4 units under limited conditions.
3. garage structures under limited conditions.
4. non-residential buildings with an occupant load of 10 or less under limited conditions.

These exceptions are further defined by the New Mexico Construction Industries Division or the local jurisdiction having authority.

In addition, the CID Rules and Regulations require that plans, specifications, and calculations for all installations with a calculated electrical service capacity over 100 kVA single phase or over 225 kVA 3 phase be stamped by an electrical engineer licensed to practice in New Mexico. (The City of Albuquerque requires an engineer's stamp if the electrical service capacity is 200 amps, single phase or 50 kVA, 3 phase.) Furthermore, the stamp of a licensed New Mexico mechanical engineer may be required on projects valued at $50,000 or more and/or on commercial buildings three stories and higher.

Alternate Materials and Methods of Construction

The provisions of the Code are not intended to prevent the use of any material or method of construction not specifically prescribed in the Code, provided any alternate has been approved and its use authorized by the building official.

Approved Plans

One set of approved plans and specifications shall be retained by the building officials and one set of approved plans and specifications shall be returned to the applicant. The applicant set shall be kept on the work site at all times during which the work authorized is in progress. The work shall comply with the approved documents and the code. No modifications shall be made unless they comply with the code.

INSPECTIONS

In general, all construction of work for which a permit is required shall be subject to inspection. The CID or its inspectors may make or require any inspections including continuous inspections to ascertain that the work complies with the provisions of the Code. Subject to the concurrence of the local building official, no work shall be done on any part of the building or structure beyond the point indicated in each successive inspection without first obtaining the written approval of the building official. No construction shall be covered without inspection approval. There shall be a final inspection and approval of all buildings when completed and ready for occupancy.

The building official may cause any structure to be reinspected.

COMPLIANCE PATHS

The Model Energy Code allows for three paths for compliance:

1. Systems Analysis and Use of Nondepletable Energy Sources (MEC Chapter 4).

2. Component Performance Approach (MEC Chapter 5).

3. Acceptable Practice (MEC Chapter 6).

While Residential construction will generally receive compliance through method 2 or 3, all three of these approaches are discussed below.

1. Systems Analysis and Use of Nondepletable Energy Sources

This procedure allows compliance based on calculations of total yearly energy use by a building and/or the use of nondepletable energy sources. The use of this approach must result in annual energy consumption of traditional energy sources equal to or less than that required to meet compliance through the Component Performance Approach for a similar building. The purpose of having an alternative design section is to allow deviation from the use of component criteria which gives specific maximum U_o-values for floors, walls, and roofs/ceilings.

Systems Analysis

If a designer wishes to design a structure which does not comply with the Component Performance Approach of the Code, the designer must compare the design to a similar structure which satisfies the Component Performance Approach. This comparison is to be submitted to the building plan checker.

The comparison consists of a calculation of annual energy consumption for the building in question and a similar building (defined as a "standard design" which is designed in accordance with either the Component Performance Approach or the Acceptable Practice Approach). In other words, a standard design meeting code requirements is analyzed to determine annual energy use. The alternative design is also analyzed.

If the alternative design uses the same amount or less energy, it is deemed to comply with the Code. If the alternative design results in an increase in one energy source use but a decrease in another source, the difference is converted to equivalent units for comparison of the total energy use. If the total annual energy consumption of the alternative design is less than the standard design, it complies.

If one wishes to use this method of compliance for a residential building, please refer to the Commercial Building Manual for a more extensive explanation of this method.

2. Component Performance Approach

This approach to code compliance requires that the thermal performance of the various components must meet or exceed certain values. If a building is both heated and cooled, the more stringent component requirements shall be used when requirements differ.

In order to provide an established format for the use of the envelope portion of the Component Performance Approach, the New Mexico Construction Industries Division has chosen to allow the compliance for One- and Two-Family dwellings to be demonstrated by the "Thermal Compliance Guide for One- and Two-Family Dwellings" developed by the National Conference of States on Building Codes and Standards. This method as modified for New Mexico will be presented in this Manual.

The Code prescribes maximum allowable heat transfer capacity for the envelope elements of all types of buildings subject to the Code. These maximums are expressed in U-values and/or R-values, and this prescription varies according to climate severity and building use.

This component approach allows trade-offs of wall U_o against roof/ceiling U_o long as the total heat gain or loss for the entire building envelope does not exceed the total resulting from complying with each component.

Thermal mass may be taken into consideration when approved by the building official. Please make sure your local building official will allow the use of Effective U-Values before you attempt to demonstrate compliance by this method.

The Code sets different component standards for Group R Residential Buildings (Type A-1 for detached one- and two-family dwellings and Type A-2 for other residential buildings, three stories or less in height) and for all other buildings. Infiltration (air leakage) rates are established for all buildings, and sealing of exterior joints is specified.

The Code sets design conditions. HVAC requirements are extensive. Equipment of all types must meet efficiency (EER) and performance (COP) standards. Design considerations such as simultaneous heating and cooling, system balancing, and economizer cycles are regulated by the Code. Thermostat capability is regulated according to function and type of occupancy. The Code sets zoning standards. Ducts and pipes must be insulated to prescribed levels.

Service water heating design, equipment selection, and performance efficiency are similarly controlled by the Code. Temperature controls are required. Hot water consumption is restricted in both shower and lavatory equipment and use.

The Model Energy Code contains sections regulating Electrical Power and Lighting - Sections 505 and 605. These sections are now incorporated into the New Mexico Energy Code. The New Mexico Electrical Code covers additional electrical requirements in buildings. Residential construction is exempt from the Electrical Requirements of the Model Energy Code.

This approach is detailed in Sections VI and VII where two residential examples are presented. Also, compliance forms have been prepared to assist the designer and building official in assessing compliance. Copies are included in the Appendix and as loose sheets in the pocket of the Manual.

3. Acceptable Practice

This section represents an effort to simplify Code compliance. Buildings with an area of less than 5,000 sf and three stories or less in height may comply under this method. This section is restricted to residential buildings which are heated or cooled, and to other buildings that are heated only.

A number of standard construction details for walls, floors, and roof/ceilings are given in the Code. The corresponding U-value for each detail is then combined in a graph with door and window area to give the U_o for the wall detail. This is then compared to maximum U_o-values prescribed to determine compliance. A similar process is followed for roof/ceilings.

Other wall, floor, and/or roof/ceiling assemblies may be used providing the designer submits documentation in accordance with accepted engineering practice indicating thermal performance of the assembly. Thermal mass may be considered when approved by the building official. Please make sure your local building official will allow the use of Effective U-Values before you attempt to demonstrate compliance by this method.

This approach provides simplified HVAC equipment performance requirements for combustion heating and unitary cooling and heating equipment with a single point of control. More complex systems must comply with the Component Performance Approach. Temperature controls and zoning are also regulated.

Service water heating controls and conservation equipment are slightly simplified but are essentially the same as in the Component Performance Approach.

Residential construction is excused from compliance with any electrical energy conservation requirements.

INTRODUCTION

Passive solar applications deal with the collection and beneficial use of solar energy without the need for parasitic energy (e.g., pumps, fans,etc.). Normally, passive solar applications deal with a combination of glazing and mass to collect and store energy during the day for use during the cooler night. While not an explicit part of the Code, New Mexico weather offers opportunities for energy conservation through passive solar applications that should not be ignored. A simplified design methodology is presented for use in residences. While the Component Performance Approach allows for trade-offs that could meet the Code exactly (e.g.,excess roof/ceiling insulation to compensate for the extra glass), this may lead to over-design and excess cost. It is suggested that the designer coordinate with the building official if passive approaches are planned.

Also covered in this section is information on Effective U-Values. Again, the use of Effective U-Values is not explicitly covered in the Code, but their use has been shown to lead to energy-conserving designs.

PASSIVE SOLAR DESIGN

It is not the purpose of this Applications Manual to teach the process of passive solar design. However, due to the favorable climate in New Mexico, it is expected that a number of residential designs will incorporate passive features. To provide some guidelines on cost-effective solar designs, the following information is provided. This material is extracted from "Conservation and Solar Guidelines" by J.D. Balcomb published in the proceedings of the 8th Passive Solar Conference held in Santa Fe, New Mexico. A complete description of how to design passive solar residences can be found in Passive Solar Heating Analysis by Los Alamos National Laboratories and available from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).

Both conservation and passive solar are proven strategies for reducing energy use in residential buildings in New Mexico. Conservation means added insulation and decreased air infiltration to reduce the gross heating energy required to maintain winter comfort, while passive solar means adding south windows, Trombe walls, or sunspaces to supply some of the gross heating requirements. The net heat required by the building is the gross heat minus the solar savings. Conservation makes the passive solar system's job easier. Good thermal design consists of achieving a proper balance between the two strategies.

Based on the methodology detailed in the referenced reports, guidelines for balancing conservation and passive solar have been developed for New Mexico. The guidelines are shown in Table 3 and give recommended values for insulation, number of glazings, and passive solar collection area (as a percentage of floor area).

TABLE 3: GUIDELINES FOR NEW MEXICO
(plus or minus 20%)

Insulation R-Value

City	Walls	Ceiling	Slab	Basement	# of Glazings	Solar Glazing
Albuquerque	15	26	11	12	2	20%
Clayton	16	28	13	14	2	21%
Farmington	17	30	14	15	3	21%
Los Alamos	18	31	14	16	3	24%
Roswell	14	24	10	11	2	18%
T or C	12	23	9	10	2	17%
Tucumcari	14	25	11	12	2	19%
Zuni	17	30	13	15	2	22%

Solar glazing is the percentage of the building floor area for south-facing glazing assuming one-story construction. For two-story construction, use 88% of the value.

The "Number of Glazings" column is for east, west, and north facing windows; south glazing layers will depend on the passive system chosen. It is assumed that the air infiltration has been reduced to less than 1/2 air change per hour. This level is appropriate for all residences whether or not passive solar systems are used. The numbers in the table are intended to be used for guidance only. These are not R-values for code compliance nor do they guarantee that a solar design will work. They indicate the levels of conservation and solar aperture which appear to be balanced for New Mexico's conditions. The designer should try to stay within 20% of the values in the early design stages. When doing schematic or design development, the techniques in the Passive Solar Heating Analysis manual should be employed. The guidelines are applicable to new residential construction or to small commercial buildings having residential levels of internal heat generation from people, lights, and equipment (roughly 30 to 60 Btu/day-sf).

The recommended total area of solar glazing is the same regardless of the passive system type. However, the performance will vary somewhat among the different system types. If the total solar glazing area is less than that recommended in Table 3, then the performance of the passive system will be reduced accordingly. The building should have adequate mass to prevent overheating. This may be a problem in direct gain systems for frame construction. In this case, the direct gain area should not exceed 5% of the total floor area or 9% if the floor is massive and not carpeted.

Beyond these limits, mass must be added along with glazing area to maintain comfort. The minimum recommended exposed mass area within the direct gain space is six times the glazing area. An effective approach is to limit the direct gain area, based on available mass, and then use an indirect system (Trombe wall or sunspace) to achieve the total passive system collection area. It is usually good practice to mix passive system types.

Summer cooling should also be a major concern to the designer, especially in the hotter areas of the State. Avoid solar gains in the summer through effective window shading and placement. Deciduous trees are particularly effective to the east and west of the house but should not be used within 45 degrees of south. With proper care, no additional cooling should be needed in the milder New Mexico climates, and evaporative cooling should be adequate in the warmer areas.

The passive system types considered in these guidelines are:

Direct Gain: The mass-surface-area-to-glass-area ratio is 6 to 1. The mass is thick masonry (4 to 6 inches thick) and the diurnal heat capacity is 72 Btu/deg. F per square foot of direct gain window area.

Trombe Wall: Unvented (venting improves performance by about 4%), 12 inch thick, dense masonry (140 to 150 lbs/cubic foot). Adobe Trombe wall is 10 inch thick (110 lbs/cubic foot).

Sunspaces: See schematics in <u>Passive Solar Heating Analysis.</u>

All systems are double glazed and should be oriented within 15 degrees of south for best performance. Tilted glazing in New Mexico usually creates more of a cooling problem than the advantage gained in improved heating performance. Night insulation will greatly improve the performance of any passive system in any climate. However, the cost effectiveness and the necessity of night insulation increases in the colder climates (climate zones 1, 2, 3, 4, and 5). In addition to improving the system performance, night insulation improves comfort by shielding the individual from an otherwise cold window surface at night.

As a general rule, the performance sensitivity of passive solar buildings to variations in design parameters increases as the solar savings increase or as the building load decreases. There is a wide range for choice when the system is providing a small part of the gross heat load, but at higher values, the designer should study the sensitivities carefully and design as close to the optimum as possible.

Remember, these are just guidelines to start on the design of a passive solar heating system for residences. The insulation levels in Table 3 may seem high, but any reduction in gross building heating load will improve the performance of a passive system. Thus, the guidelines represent a reasonable balance between conservation levels to reduce the gross building load and passive solar to provide some of the heating as required.

Radiant Heating and Cooling Equivalents

Indoor surrounding air design temperatures for buildings with radiant heating (e.g., from passive solar designs) or cooling may be modified to create the same comfort level as would be achieved with a different system using the tabulated design temperatures. Depending upon the designed mean radiant temperatures of the room surfaces, surrounding air temperatures with radiant heating systems may be lower for winter than given, and these temperatures may be higher than given for summer with a radiant cooling system.

A room's mean radiant temperature means that the radiant temperature is roughly the average temperature of the floor, walls, and ceiling. The chart below shows combined pairs of temperatures which all give the same relative feeling of comfort (i.e., 70 deg. F).

Equivalent Air and Radiant Temperatures (deg. F)

Air Temperature	49	56	63	70	77	84	91
Mean Radiant Temperature	85	80	75	70	65	60	55

For example, if the air temperature (AT) is 70 deg. and the mean radiant temperature (MRT) is 70 deg., we feel like it is 70 deg., but if AT is 84 deg. and the walls, floor, and ceilings are so cold that MRT is 60 deg., we still feel like both are 70 deg., but we may not be as comfortable. (This is a common situation in poorly insulated homes with forced air heating.) On the other hand, if MKT is 75 deg., we can let AT drop to 63 deg. and still feel like everything is 70 degrees. (This can occur in a passive solar home with warm walls or a warm floor.) Verifying calculations should be submitted to the building code official if radiant systems are used.

EFFECTIVE U-VALUES

Effective U-Values represent an average response of building materials to an average winter week with average temperature and solar radiation. Effective U-Values are indicative of the interaction between solar radiation and thermal insulation. They are intended to be used to estimate actual energy use for complying with prescriptive building code requirements.

Effective U-Values should not be used when sizing heating equipment as they represent average performance and do not account for peak effects.

Effective U-Values are a result of research carried out in the late 1970's sponsored by the State of New Mexico Energy and Minerals Department and the New Mexico Energy Institute. Copies of the reports on Effective U-Values for wall sections and windows or roofs/ceilings may be obtained from the New Mexico Research and Development Institute.

At the time Effective U-Values were developed, the State was represented climatically by 11 Climatic Regions. Figure 2 shows the 11 regions, and Table 4 lists the major population areas by each region. (Note that Figure 2 should only be used with Effective U-Values. In all other applications in the New Mexico Energy Code, Figure 1 should be used to identify climate zones.) This is followed by Table 5 which lists 26 wall sections analyzed for Effective U-Values. Illustrations and Effective U-values of the 26 wall sections are located in Appendix D. Also included in Appendix D are single and double glazing sections. Finally, the Appendix has a Table of Roof/Ceiling Effective U-Values.

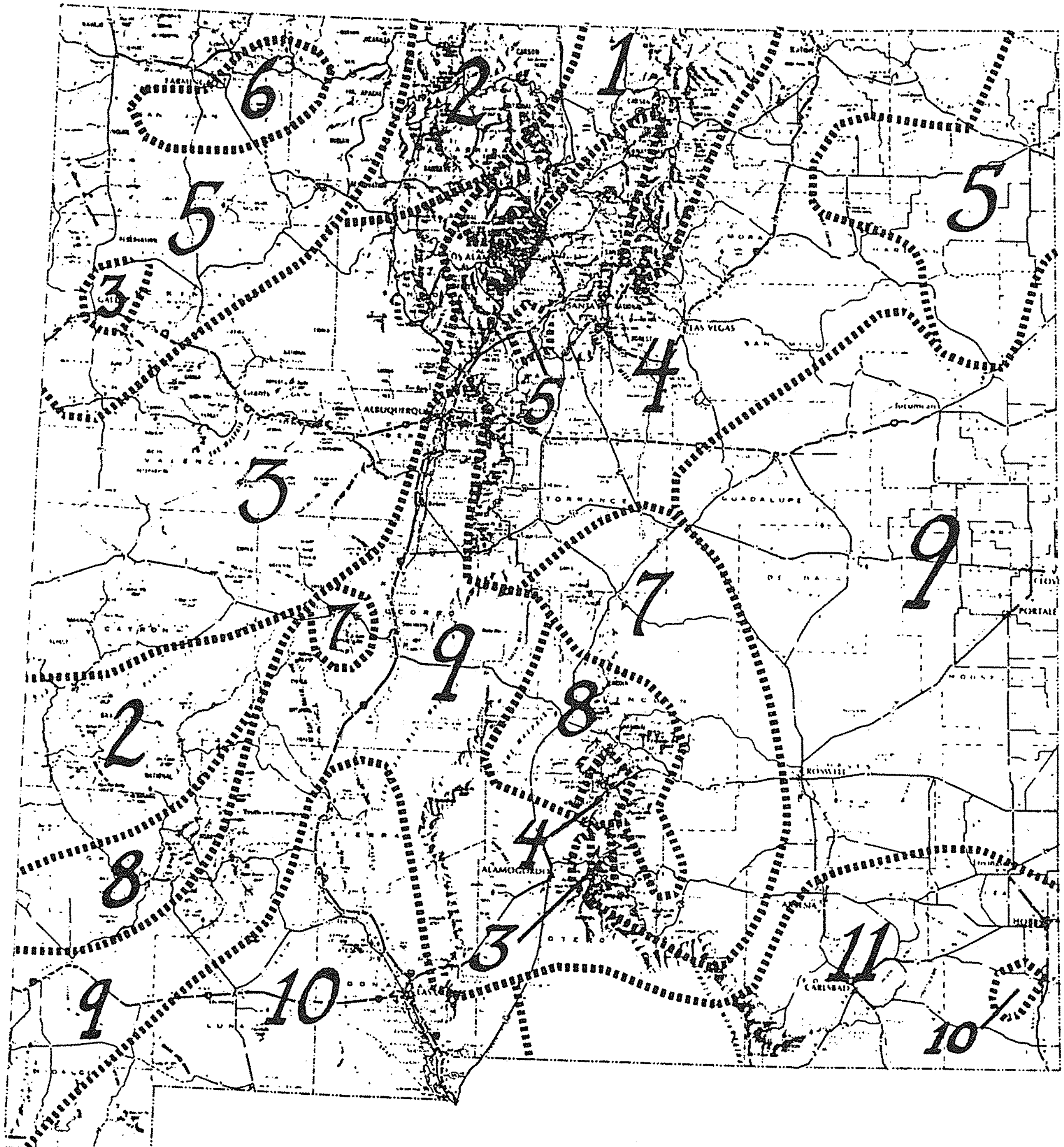


FIGURE 2: NEW MEXICO CLIMATE REGIONS FOR EFFECTIVE U-VALUES

TABLE 4: POPULATION AREAS BY CLIMATIC REGION FOR EFFECTIVE U-VALUES

Climatic Region 1:
- Eagle Nest
- Questa
- Red River

Climatic Region 2:
- Chama
- Cuba
- Tierra Amarilla

Climatic Region 3:
- Cloudcroft
- Gallup
- Grants
- Luna Range

Climatic Region 4:
- Cimarron
- Las Vegas
- Los Alamos
- Mountainair
- Raton
- Ruidoso
- Sandia Ranger Station
- Santa Fe
- Springer
- Taos
- Las Cruces

Climatic Region 5:
- Aztec Ruins
- Chaco Canyon
- Clayton
- Farmington
- Shiprock

Climatic Region 6:
- Bloomfield

Climatic Region 7:
- Magdelena
- Corona
- Mayhill

Climatic Region 8:
- Carrizozo
- Silver City

Climatic Region 9:
- Alamogordo
- Albuquerque
- Clovis
- Lordsburg
- Roswell
- Socorro
- Tatum
- Tucumcari
- Vaughn
- White Sands

Climatic Region 10:
- Deming
- Truth or Consequences

Climatic Region 11:
- Artesia
- Carlsbad
- Hobbs
- Orogrande

TABLE 5: LIST OF EFFECTIVE U-VALUE WALL SECTIONS CONVENTION: OUTSIDE-INSIDE

Wall No.	Description
1	3/4" stucco; 10" adobe; 1/2" plaster
2	3/4" stucco; 14" adobe; 1/2" plaster
3	3/4" stucco; l" polystyrene; 10" adobe; 1/2" plaster
4	3/4" stucco; l" polystyrene; 14" adobe; 1/2" plaster
5	3/4" stucco; 2" polystyrene; 14" adobe; 1/2" plaster
6	3/4" stucco; 10" adobe; 2" batt; 1/2" plaster
7	3/4" stucco; 10" adobe; 2" batt; 1/2" gyp board
8	3/4" stucco; 14" adobe; 3-1/2" batt; 1/2" gyp board
9	8" light wt. block, unfilled; paint
10	8" standard conc. block, unfilled, paint
11	8" light wt. block, vermiculite fill; paint
12	8" standard conc. block, unfilled; 3-1/2" batt; 1/2" board
13	6" thru wall brick, unfilled
14	8" thru wall brick, unfilled
15	6" thru wall brick, vermiculite fill
16	8" thru wall brick, vermiculite fill
17	Brick veneer; 3/4" air space; 1/2" fiberboard; 2x4 studs; full 3-1/2" batt; 1/2" gyp board
18	Brick veneer; 3/4" air space; 1/2" fiberboard; 2x4 studs; 2" batt; 1/2" gyp board
19	l" stucco; 1/2" fiberboard; 2x4 studs; no insulation; 1/2" gyp board
20	l" stucco; 1/2" fiberboard; 2x4 studs; 3-1/2" batt; 1/2" gyp board
21	1" stucco; 1/2" fiberboard; 2x4 studs; 3-1/2" batt; 1/2" gyp board
22	l" stucco; 1/2" fiberboard; 2x6 studs; 6" batt; 1/2" gyp board
23	Brick veneer; 3/4" air space; 1/2" fiberboard; 2x6 studs; 6" batt; 1/2" gyp board
24	Brick veneer; 3/4" air space; technifoam; 2x4 studs; 3-1/2" batt; 1/2" gyp board
25	l" stucco; l" technifoam; 2x4 studs; 3-1/2" batt; 1/2" gyp board
26	7-1/4" x 8-1/2" pine logs with splines

Illustrations of these wall sections and their Effective U-Values are found in Appendix D.

INTRODUCTION

In this section compliance by Thermal Component Approach through the Thermal Compliance Guide Approach and by the Acceptable Practice method will be presented.

Compliance with the Code for a residence can be demonstrated through three paths, as described in Section IV. Code Compliance. The Component Compliance Approach should be used through the "Thermal Compliance Guide Approach." Please note that, compliance can be demonstrated by brute force through calculating all component U-values and comparing them to the allowable values, but this "Thermal Compliance Guide" approach is presented here because the amount of work is much, much less and the organization of the approval is simple.

The Thermal Compliance Guide with all of its original tables and charts is printed within this Manual as Appendix F. Please read that material for thorough descriptions of the various steps, but studying the following examples will provide a working knowledge of the procedure. The procedure involves the completion of one and sometimes two forms. The first form, Applications Worksheet, is required for every job, and, when filled in showing compliance, it can be submitted along with the required drawings for permit.

COMPLIANCE THROUGH COMPONENT PERFORMANCE APPROACH

Thermal Compliance Guide Method

This Process involves the completion of the "Applications Worksheet" for every house and the Trade Off Worksheet when it becomes required. Information necessary to complete these worksheets has been assembled and appears in Appendix A. Complete the following steps to demonstrate compliance:

Step 0: Fill in the general information at the top of the form. Obtain the address, location etc. for the house. Determine the Heating Degree Days for the site from page A-1.

Step 1: **Roof/Ceiling**: Calculate the areas of the Flat Roof and Cathedral Roof portions of the house and insert the values in the Column for "Area." Using the R-value of the insulation installed, determine the "System R_o" for the roof from the "Roof/Ceiling Assembly R-value" Table page A-2. Total the "Area" and "Area X 1/R" columns. Divide the total of the "Area" column by the Total of the "Area X 1/R" column to determine the "Average R_o" for the Roof/Ceiling. Look up the "Required R_o" found on A-1. If the "Average R_o" is greater than the "Required R_o," then the Roof/Ceiling complies and a check is placed in the "Meets MEC" column.

Insert the skylight area as a percent of the total roof area. If the skylight area is less than 1% of the roof area, the skylight area can be ignored, and a check may be placed in the "Meets MEC" column. If the skylight area is greater than 1%, the actual weighted average for the Roof/Ceiling must be calculated and compared to the required value.

Step 2: **Openings**: Calculate the areas of the Openings in the walls and place the results the "Area" column. Obtain the R-values for each opening type from page A-3 and insert the values in the "R-value" column, and insert the result of multiplying each area times 1/its R-value in the "Area X 1/R-value" column. Total "Area" and "Area X 1/R" columns and divide the total of the "Area" column by the total of the "Area X 1/R" column to obtain the "Glazing R_o."

Step 3: **Exterior Walls**: Total the "Gross Wall Area." Divide "Open Area Total" from the previous step by the "Gross Wall Area" and insert the result in the "Percent Open" box. Insert the "Installed R-value" and determine the "System R_o" from the tables on A-2. Locate the Interpretive Requirements Table, pages A-4 through A-8, for the Heating Degree Days for the site. Using "Percent Open" as the "percentage glazing, look up the "Required R_o" for the wall in the Interpretive Requirements Table. If the System R_o is greater than the "Required R_o" then the wall comply and place a check in the "Meets MEC" column.

Step 4: **Other Components**: Check Compliance each of the other components. Look up the required values in Appendix A (Note that the "Crawlspace R_o," "Basement R_o," and "Other R_o" must be looked up in the Code directly) and compare each with the component's "System R_o." If the all R_o's are greater that the required values, your task is complete. If not in compliance, continue, fill in the Trade Off Worksheet to determine most desirable way to make the changes necessary for compliance.

Step 5: **If not in compliance, complete Trade Off Worksheet.**

The examples will be presented step by step. The worksheet will be presented on the adjacent page.

Necessary Resources

The advantage of this Thermal Compliance Guide method is that the R_o values for many building components used in New Mexico have been calculated and can be looked up and used in the form. Calculations for other types of wall sections may be necessary when values cannot be found in the tables. For convenience, the following tables from the Thermal Compliance Guide as follows have been reproduced and they appear in Appendix A. When filling out the Application Worksheet, opening to Appendix A will generally be all that is needed to locate the values needed in the form.

Contents of Appendix A - Resource Tables

For non-listed constructions, the R-value for the entire system must be calculated. A discussion of R-values and U-values is presented in Section II, Energy Fundamentals. In order to calculate the R-value of each wall, the R-value of each material must be looked up in a chart or table. A table of useful R-values of Common Building Materials is located in Appendix C and Typical Wall Sections, complete with calculated R-values is in Appendix E. Other sources for these values are the Thermal Compliance Guide and various references provided in the Model Energy Code.

The Interpretive Requirement Tables appearing in the Appendix pages A-4 through A-8 provide a simple "look up" way to determine values for a particular glazing R-value and glazing-to-wall-area percentage which the R-value needs to be for the opaque wall. These Interpretive Requirement Tables also appear in the Guide on pages 10 through 14.

A series of worksheets, located in Appendix G, set up a sequence of calculation steps:

- R_o and U_o Calculations for Walls
- R_o and U_o Calculations for Roofs/Ceiling
- R_o and U_o Calculations for Floors

Calculation of Weighted Averages

When one is faced with calculating the R_o for a wall not found in the Appendix A table, one must be prepared to calculate weighted averages for different parts of a building envelope element.

In most buildings a wall is composed of more than one part or wall section type. A stud wall is considered to have two parts, the wood framing and the cavity between the frame. In addition, the wall may have additional parts if there are doors or windows. Because the materials are different in each section, the R-value is different. Another example is an insulated concrete block wall with windows. The wall materials will have one R-value and the glass will have another.

In order to calculate the R-value of the wall, the R-values and areas of the different materials must be "averaged" into one R-value. This average is called a **weighted average.** When one needs to determine the overall effect of R-value when there are several R-values in a wall or roof, one combines them by weighted average. The resulting R-value is a fictitious R-value, however the weighted average R-value has the same effect as the combination of R-values actually being installed. This weighted average is developed by multiplying each R-value by its area and adding these together. The resulting sum is divided by the entire area (the sum of the individual areas).

Basements, Crawl Spaces, and Heated Slabs

Slab floors having heating pipes or ducts under the slab are a common construction detail. Such slabs should be considered as a heated slab for purposes of determining perimeter insulation for Code compliance.

Temperatures in crawl spaces will vary widely. As a practical matter, calculations for floors over crawl spaces should consider the temperature and wind speed to be the same as used in other envelope heat loss calculations.

Basement walls exposed to the outdoor air are treated as described as follows: A basement wall which has more than 50% of its gross area above grade is not considered a basement wall, but is included as a wall element in the wall category. All doors and windows in these walls are included with the other doors and windows in the residence.

A basement wall which has 50% or less of its area above grade is a basement wall. The windows and doors are included with the windows and doors in the wall calculations. Only the opaque area of the basement wall is considered, but the entire area is included whether it is below grade or not. A basement wall of a heated basement must be insulated and the overall R-value must exceed that in the Interpretive Requirements Tables.

COMPLIANCE THROUGH ACCEPTABLE PRACTICE

It may not be necessary to complete all the preceding calculations to check for Code compliance. Many conventional building designs and materials in residential structures and small commercial buildings can be more easily checked for envelope thermal performance by what is called Acceptable Practice.

Specifically, the procedure can be utilized for buildings of less than 5,000 square feet in gross floor area and less than four stories in height. In addition, this procedure is limited to residential buildings that are heated or mechanically cooled and to other buildings that are heated only. In general this compliance procedure is more conservative than other procedures.

A number of typical opaque wall, ceiling and floor assemblies are illustrated in the Appendix of the Model Energy Code. The illustrated details provide the U-value associated with each detail. The procedure, then, is to complete the following steps.

Step 1: Locate the appropriate detail and determine the U-value of the walls.

Step 2:. Modify the U-value of the wall as necessary according to the amount of windows, doors, skylights, etc.

Step 3: Compare the U-value with the Code requirements.

Step 4: Complete Steps 1-3 for Roof/Ceiling

Step 5: Complete Steps 1-3 for Floors

Step 6: Complete the Acceptable Practice Approach Form

EXAMPLES

INTRODUCTION

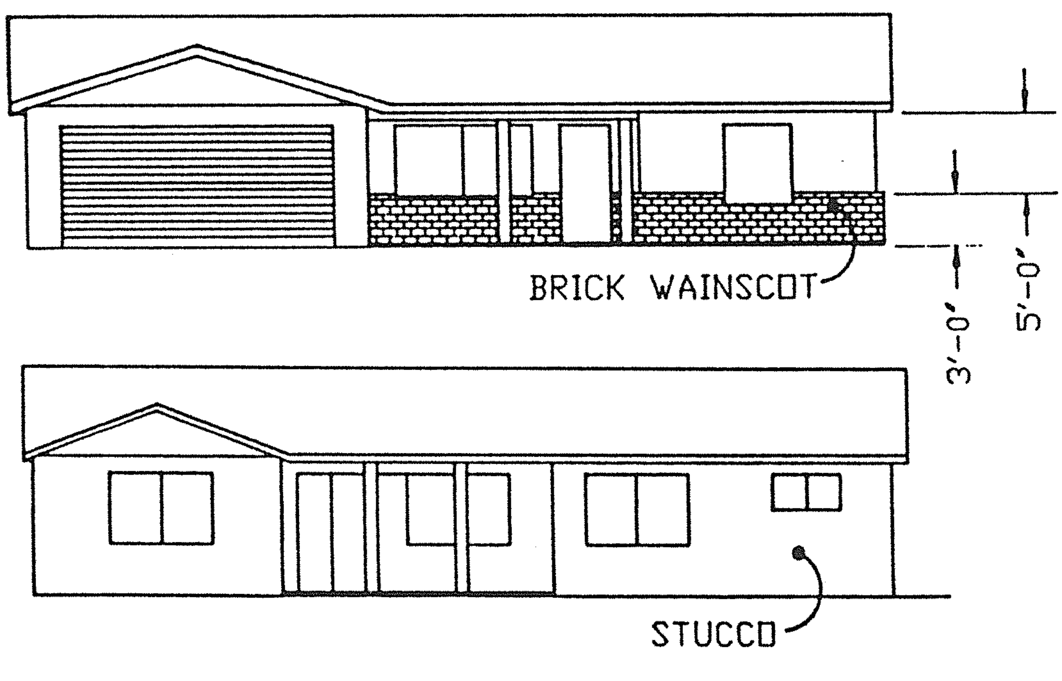
Two examples of Code compliance for residential applications are presented in this section. The first example is a single family detached house and the second example is a two story single-family detached house. Each example is analyzed in two climate zones. Both examples are analyzed with the Component Performance Approach and the first example is also analyzed by Acceptable Practice.

Example 1-A: Single-Family Detached Residence in Albuquerque
Example 1-B: Single-Family Detached Residence in Taos
Example 1-C: Acceptable Practice Analysis of 1-A

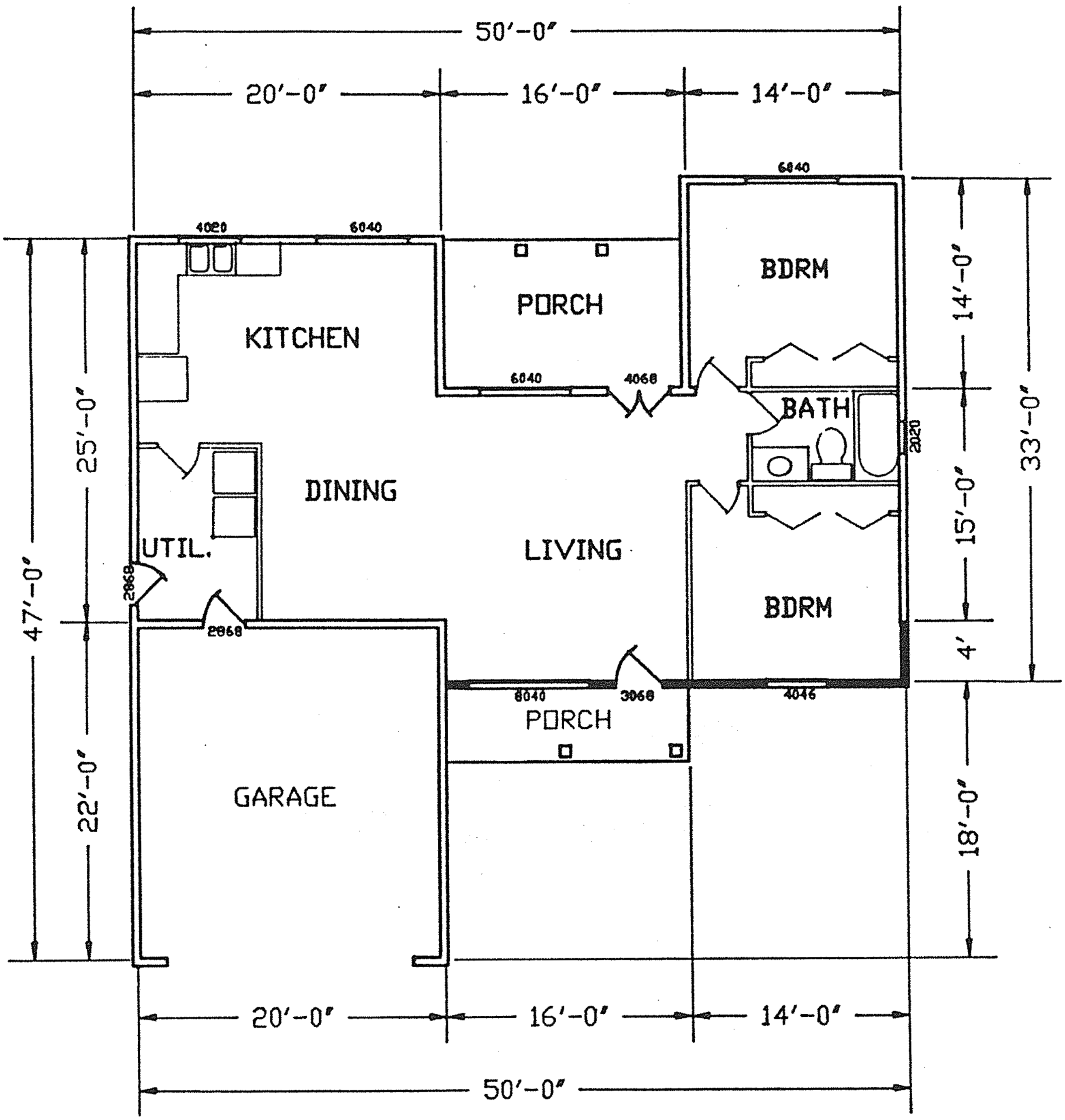
Example 2-A: Single-Family Two Story Residence in Las Cruces
Example 2-A: Single-Family Two Story Residence in Farmington

EXAMPLE 1-A: SINGLE-FAMILY DETACHED RESIDENCE IN ALBUQUERQUE

Example 1 is a one-story, framed stucco residence with an attached, unheated garage, slab-on-grade floor, and a pitched roof. Elevations are shown below, and a plan and details are shown on the following pages.

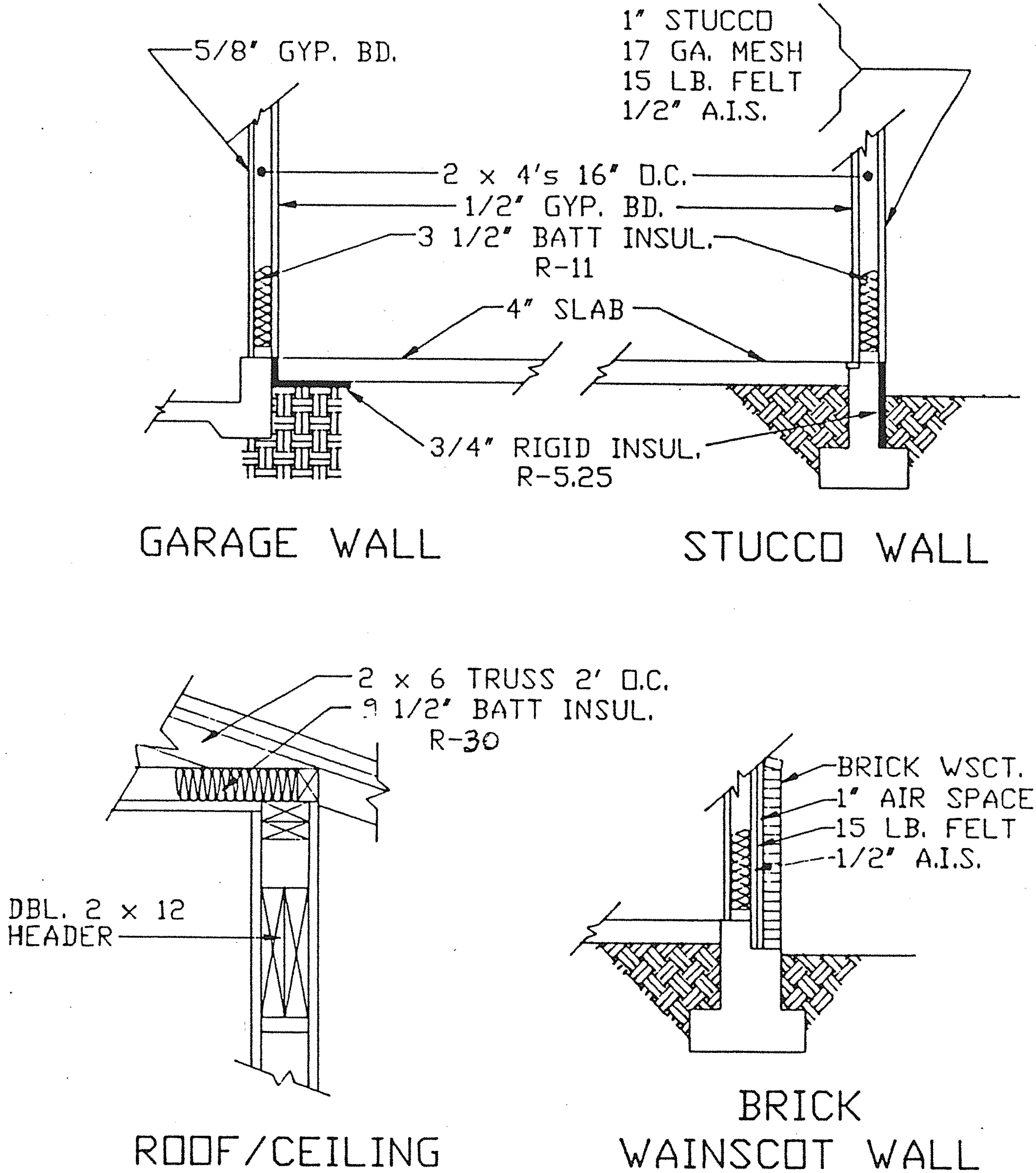


TOP: Front Elevation **BOTTOM: Rear Elevation**



FLOOR PLAN

EXAMPLE 1: SINGLE-FAMILY DETACHED RESIDENCE



WALL SECTIONS

EXAMPLE 1: SINGLE-FAMILY DETACHED RESIDENCE

EXAMPLE 1-A

Applications Worksheet

Builder Name: JACKSON BURTON　　Date 12-20-93
Address: ALBUQUERQUE, N.M.
Submitted by: BUILDER　　Phone: #
Building Address: HOPI NE, ALBUQUERQUE, N.M.
Legal Descr. Lot: ______ Section: ______ County: ______
General Descr. ______
Local HDD 4332　　Building Area: 1700 sf

Roof/Ceiling

Ceiling Type	Area, sf	R-value installed	System R_o From Page A-2	AreaX1/R_o	Meets MEC
Flat Ceiling	1266	30	31.1	40.7	
Cathedral Ceiling					
Totals, Total "Area" and "AreaX1/R_o" columns.	1266			40.7	
Required R_o from Appendix A-1, Compare to "Ave. R_o" If "Ave. R_o" is greater than Required R_o, check "Meets MEC" column.	29.4		Ave. R_o = Tot. "Area" ÷ "A X 1/R"	31.1	✓
Skylight Percent, must be less than 1%	Ø %				✓

The example will be presented step by step. Refer to Section V, Thermal Compliance, for a descriptions of steps. The worksheet will be presented on the adjacent page.

Step 0: Complete General Information

Fill in the blanks at the top of the Applications Worksheet.

Job Location:	Albuquerque, NM
Heating Degree Days:	4332 from page A-1 in Appendix A.

Step 1: Roof/Ceiling Areas

The house has a pitched roof and a vented attic. Since the attic is vented, the roof does not retard heat flow. Only the insulation on top of the ceiling and the ceiling itself will are involved in the resistance. The area of the roof is length times width.

$$A_o = (20 \times 25) + (16 \times 19) + (14 \times 33) = 1{,}266 \text{ sf}$$

The roof/ceiling is insulated by R-30 batts, so write 30 in the "R-value Installed" box. Look up the "System R_o" on page A-2 of the Appendix. The trusses are 24 in. O.C. so the "System R_o" is 31.1. Place this value in the box. Multiply the "Area" by 1/System R_o and place this number, 40.7, in the right most column. Total the "Area" and "Area X $1/R_o$" columns. Determine the "Ave R_o" by multiplying the total "Area" by the Total "Area X 1/R" yielding 31.1. Note that since this example has only one ceiling type, the average is the same as the System R_o.

Look up the Roof/Ceiling R_o required, appearing on the Table in Appendix A-1, and shown below. For this case, Albuquerque, the R_o is 29.4. <u>The "System R_o" for the example house of 31.1 is greater than the required R_o of 29.4 so the roof is in compliance, place a check in the "Meets MEC" column.</u>

The house does not have skylights, so enter 0% in the box and check the compliance box.

Sample of Table from Appendix A

RESIDENTIAL BUILDINGS IN NEW MEXICO
Minimum Ro Values allowed by Code

City	Heating Degree Days 65 F	Min Ro: Roof/Clg	Min Ro: Walls A-1	Min Ro: Walls A-2	Min Ro: Flrs Over Unheated Spaces	Floor Slabs Min Ro: Heated	Floor Slabs Min Ro: Unhtd.	Floor Slabs Insul Depth Inches
Alamogordo	3053	24.9	5.8	3.0	20	6.0	4.0	24
Albuquerque	4332	29.4	6.6	3.2	20	6.0	4.0	24
Artesia	3366	25.9	6.0	3.1	20	6.0	4.0	24
Carslbad	2813	24.2	5.7	3.0	20	6.0	4.0	24
Carrizozo	4234	29.0	6.5	3.2	20	6.0	4.0	24

Openings

Opening Type	Area	R-value From Page A-3	Area X 1/R
Window Type 1	134	1.72	77.9
Window Type 2			
Slider			
Basement Window			
Door	82	3.03	27.1
Open Area Total Sum the "Area" and "Area X 1/R" columns.	216		105.0
Glazing R_o Divide total "Area" by Total "A X 1/R"	2.06		

Exterior Walls

				Meets MEC
Gross Wall Area	1488	Percent Open Divide the Open Area Total by the Gross Wall Area.	14.5	
		Wall R-value Installed	11	
Wall R_o Required from Appendix A, Interpretive Requirements Tables. If "System R_o-value" is greater than "Wall R_o Required" Check "Meets MEC" column.	11.64	System R_o-value from Tables in Appendix A.	11.83	✓

Step 2: Openings

Determine the areas, manufacturers, and other information about the openings in the exterior walls. These areas must be measured from the plans for the house. Look up the R_o values in the table on A-3.

Element	Area, sf	R_o
Window, Type 1	134	1.72
Window, Type 2	0	
Slider Area	0	
Basement window	0	
Door Area	82	3.03

Multiply each area by "1/R-value" and insert the number in the right most column. Total the "Area" and "Area X 1/R" columns. Divide the total opening area, 216, by the total of the "Area X 1/R" column, 105.0, and place the result in the "Glazing R_o" blank. This number represents an overall average of the R-values of all of the non-wall elements of the envelope.

Step 3: Exterior Walls

Calculate the gross wall area and place the number in the box. The Gross Wall Area is generally the perimeter, 186 ft., times the height, 8 ft. If cathedral ceilings are involved, the areas should be calculated from the elevations in the plans.

Gross Wall 186 feet x 8 feet = 1,488 sf

Calculate the percent open by dividing the Gross Wall Area into the Total Open Area from the previous step.

For this example this is 216/1488 = 14.5%.

Determine the wall insulation to be installed, in this case, R-11. Using the Table found on page A-2 of Appendix A. Locate the "System R_o" for the wall approximating that of this house. The best number is the first one, 11.83. Write this number in the system R_o box.

Now, find the Interpretive Requirements Table for this project. This means looking through the tables located on pages A-4 through A-8 and finding the table with the HDD range including the HDD for the project site.

For this project with HDD = 4332, the project table is the lowest of the three on page A-6. The HDD can be located in the upper left corner of each table. This portion of this table is shown below.

HDD	R_o-VAL	R_o-VAL	R_o-VAL
4001-	ROOF: 30.12	UNHEATED SLAB: 4.00(24")	CRAWL WALL: 13.13
4500	FLOOR: 20.00	HEATED SLAB: 6.00(24")	BSMT WALL: 10.00

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	18.73	23.39									
1.5 (0.67)	11.06	11.91	12.93	14.17	15.72	17.69	20.30	23.91			
2.0 (0.5)	9.18	9.57	10.00	10.48	11.02	11.64	12.35	13.17	14.13	15.27	16.65
2.5 (0.4)	8.33	8.55	8.80	9.06	9.34	9.65	9.99	10.37	10.78	11.24	11.76
3.0 (0.33)	7.85	7.99	8.14	8.31	8.48	8.67	8.87	9.08	9.31	9.56	9.83
3.5 (0.29)	7.53	7.63	7.74	7.84	7.96	8.08	8.21	8.34	8.49	8.64	8.80
4.0 (0.25)	7.31	7.38	7.45	7.53	7.61	7.69	7.77	7.86	7.96	8.06	8.16

The Interpretive Requirements table is used to establish the "Wall R_o Required" for the opaque area of the wall. Enter the Table from the right using the "Glazing R_o" determined in the preceding step, namely 2.06.

> Use the Row with R = 2.0, read across the top of the Table until you get to the column with a percentage equal to or greater than the "Percent Open," 14.5%, calculated above. For this example, the percent column to use is the 15% column because it is the first column greater than 14.5%. Locate the number at the intersection of this column with the previously selected row.

The number is 11.64. This is the "Wall R_o Required" for the Wall Assembly.

Compliance for this wall occurs because the "System R_o" of 11.83 is greater than the require R_o of 11.64. This wall just barely pass. Place a check in the "Meets MEC" column next to the "System R_o" box.

Step 4: Other Components

To establish the compliance of the other components, complete the next box. The plans for this house call for concrete slab-on-grade construction. From the wall sections for this example, the slab floor is unheated, the insulation value is R-5.25, and the insulation extends down 24 inches. Insert this information in the form.

The required minimum slab perimeter R-value and slab perimeter insulation depth come from the Table on A-1. They are R= 4.00 and 24 in. for Albuquerque.

The slab perimeter insulation complies in both R-value and depth. Place checks in the "Meets MEC" column for these two elements.

Other Components

	Required From Tables in Appendix A.		Installed Value	System R_o From Tables in Appendix A.	Meets MEC
Floor R_o					___
Slab Insulation R-value	4.0		5.25		✓
Slab Insulation depth	24"		24"		✓
Crawlspace R_o					___
Basement R_o-value					___
Other R_o					___
Other R_o					___

COMPLIANCE CERTIFICATION

This Residence Meets the 1992 Model Energy Code

Builder/Designer ________ Company Name ________ Date ________

Building Official ________ Jurisdiction ________ Date ________

A review of the form shows that there is a check in the "Meets MEC" column for every element in this house. The thermal envelope of this house complies with the Model Energy Code. Submit a copy of this form with other permit application documents. The compliance of the mechanical systems must also be verified and the blank on the form checked.

Note that if one of the components did not comply, the "Trade Off Worksheet" could be used to determine the best way to make changes toward compliance.

EXAMPLE 1-B

Applications Worksheet

Builder Name: DELL FURNAM Date 12-20-93
Address:
Submitted by: Phone:
Building Address: E. PASEO DEL NORTE, TAOS, N.M.
Legal Descr. Lot: Section: County:
General Descr.
Local HDD 6827 Building Area: sf

Roof/Ceiling

Ceiling Type	Area, sf	R-value installed	System R_o From Page A-2	AreaX1/R_o	Meets MEC
Flat Ceiling	1266	30	31.1	40.7	
Cathedral Ceiling					
Totals, Total "Area" and "AreaX1/R_o" columns.	1266			40.7	
Required R_o from Appendix A-1, Compare to "Ave. R_o." If "Ave. R_o" is greater than Required R_o, check "Meets MEC" column.	38.5		Ave. R_o = Tot. "Area" ÷ "A X 1/R"	31.1	
Skylight Percent, must be less than 1%	0%				✓

Openings

Opening Type	Area	R-value From Page A-3	Area X 1/R
Window Type 1	134	1.72	77.9
Window Type 2			
Slider			
Basement Window			
Door	82	3.03	27.1
Open Area Total Sum the "Area" and "Area X 1/R" columns.	216		105.0
Glazing R_o Divide total "Area" by Total "A X 1/R"	2.06		

EXAMPLE 1-B: SINGLE FAMILY DETACHED RESIDENCE IN TAOS

Example 1-B is the same one-story, framed stucco residence used in Example 1-A. The difference at the outset is that R-21 batts are to be installed in the walls which would be 6 in. studs. The example will be presented step by step, refer to Section VI, Thermal Compliance, for Steps. The worksheet will be presented on the adjacent page.

Step 0: Complete General Information

Fill in the blanks at the top of the Applications Worksheet.

Job Location:	Taos, NM
Heating Degree Days:	6827 from A-1 in Appendix A.

Step 1: Roof/Ceiling Areas

The values entered in the Roof/Ceiling box are the same as for Example 1-A, except for the Roof/Ceiling "Required R_o."

Look up the Roof/Ceiling R_o required, appearing on the Table in Appendix A, page A-1. For this case, Taos, the R_o required is 38.5. Place that number in the "Required R_o" box. The system R_o of 31.1 is less than the required R_o of 38.5 so the roof is in not in compliance, <u>do not place a check in the "Meets MEC" column.</u>

The house does not have skylights, so enter 0% in the box and check compliance.

Step 2: Openings

The values entered in the Openings box are the same as for Example 1-A.

Step 3: Exterior Walls

The "Gross Wall Area" and "Percent Open" are the same as for Albuquerque.

The wall has R-21, so looking on A-2, locate the system R_o for the wall approximating that of this house. The best number is 19.21. Write this number in the "System R_o" box.

Now, find the Interpretive Requirements Table for this project. This means looking through the tables on pages A-4 through A-8 and finding the table serving the HDD range including the HDD for the project site. For this project with HDD = 6827, the job table is the lower table on page A-8. The HDD are located in the upper left corner of each table.

Exterior Walls

				Meets MEC
Gross Wall Area	1488	Percent Open Divide the Open Area Total by the Gross Wall Area.	14.5%	
		Wall R-value Installed	21	
Wall R_o Required from Appendix A, Interpretive Requirements Tables. If "System R_o-value" is greater than "Wall R_o Required" Check "Meets MEC" column.	24.29	System R_o-value from Tables in Appendix A.	19.21	

Other Components

	Required From Tables in Appendix A.		Installed Value	System R_o From Tables in Appendix A.	Meets MEC
Floor R_o					
Slab Insulation R-value	5.5		6.00		✓
Slab Insulation depth	48		48		✓
Crawlspace R_o					
Basement R_o-value					
Other R_o					
Other R_o					

COMPLIANCE CERTIFICATION

This Residence Meets the 1992 Model Energy Code

Builder/Designer ______ Company Name ______ Date ______

Building Official ______ Jurisdiction ______ Date ______

The Interpretive Requirements table is used to establish the minimum R_o required for the opaque area of the wall. Enter the Table from the right using the "Glazing R_o" determined in the preceding step, namely R_o = 2.06. Use the Row with R = 2.0. Read across the top of the Table until you get to the column with a percentage equal to or greater than the percent open calculated above. For this example, the percent column to use is the 15% column because it is the first column greater than 14.5%. Determine the number at the intersection of this column with the previously selected row.

The number is 24.29. This is the Code-required minimum "System R_o" for the Wall Assembly.

In order to have compliance for the wall, the system R_o of must be greater than the require R_o of 24.29. This wall does not comply, because 19.21 is not greater than 24.29. Do not place a check in the "Meets MEC" column next to the system R_o box.

Step 4: Other Components

To establish the compliance of the other components, complete the next box. The plans call for an unheated concrete slab-on-grade construction. For this example, the slab floor is unheated, the insulation value is R-5.25 and the insulation extends down 24 in. Insert this information in the form.

The required slab perimeter R-value and slab perimeter insulation depth come from the A-1 for Taos. They are R = 5.5 and 48 in.

The slab perimeter insulation does not comply in either R-value or depth. Do not place a check in the "Meets MEC" column.

Since this house does not comply. Some changes must be made. Let's say that the builder can easily make the slab perimeter insulation comply by increasing the r-value from 5.25 to 6.00 and extending the installation to 48 in. The Application Worksheet should be edited as indicated to bring this component into compliance.

Now the roof/ceiling and walls are not in compliance. To continue, a Trade Off Worksheet should be filled out to establish which elements might be adjusted to bring the house into compliance.

EXAMPLE 1-B

Trade Off Worksheet

Builder Name: DELL FURNAM Date 12-20-93
Address:
Submitted by: Phone:
Building Address: E. PASEO DEL NORTE, TAOS, N.M.
Legal Descr.Lot: Section: County:
Local HDD 6827 Building Area: sf

YOUR HOUSE **CODE HOUSE**

Roof/Ceiling

	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$				
Ceiling/Attic	1266	31.1	40.7				
Cathedral							
Skylight							
Total	1266				Area	Required R from A-1	AreaX1/R
Total Area X 1/R Sum the "Area X $1/R_o$" Column			40.7		1266	38.5	32.9

Wall

Opening Type	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$				
Window, Type 1	134	1.72	77.9				
Window, Type 2							
Slider							
Basement Window							
Door	82	3.03	27.1				
Other							
Opaque Area	1272	19.21	66.2				
Total	1488				Area	Required R From A-1	Area X 1/R
Total Area X 1/R			171.2		1488	8.9	167.2

Step 5 Trade Off Worksheet

In order to determine whether or not the residence complies, the Trade Off Worksheet is used. The Trade Off Worksheet allows us to quickly determine the compliance of the total building when one or more individual components is out of compliance. Basically, the Area X 1/R for all elements is determined and summed. This total is compared to the total of the Areas X 1/R for a residence with the same areas but in which each element is in compliance. Refer to the Thermal Envelope Compliance Guide for additional description about this procedure.

Using the information calculated in the previous worksheets, fill in the section under "Your House."

Roof/Ceiling: Enter the area, 1266, and the system R-value of 31.1. The calculation is Area A X $1/R_o$ = 1,266 X 1/31.1 = 40.7, and so on for the other materials.

The section under "Code House" is completed by selecting allowable R-values for the City from the Table on A-1.

As can be seen, the Area X 1/R for the Roof/Ceiling is 40.7 which is greater than the Area X 1/R for the Roof/Ceiling of the "Code House", 32.9. This one component does not comply, as was noticed earlier.

Wall: The total of the "Area X 1/R" column for Our House is 171.2 and for the "Code House" is 167.2. The wall does not comply.

Floor

	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$		Area	R	Area X 1/R
Floor Over Crawlspace							
Cantilevered Floor							
Slab Ht? Unht?	UHTD						
Slab	Perim X Depth 186 x 4	R 6.0	124		PerimXDepth 186 x 4	R 5.5	135.3
Total Area X 1/R			124				135.3

Basement Wall

	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$		Area, sf	Required R From Code	Area X 1/R
Opaque Area	/		/				/

Crawlspace Wall

	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$		Area, sf	Required R From Code	Area X 1/R
Opaque Area	/		/				/

Totals, Roof/Clg, Walls, Floors, Basement Walls, Crawlspace Walls	335.9		**Totals, Roof/Clg, Walls, Floors, Basement Walls, Crawlspace Walls**	335.4

If the total for YOUR HOUSE is less than the total for CODE HOUSE, your house is in compliance.

COMPLIANCE CERTIFICATION This Residence Meets the 1992 Model Energy Code

Builder/Designer ____ Company Name ____ Date ____

Building Official ____ Jurisdiction ____ Date ____

Floor: The floor is a slab, so the Area X 1/R is calculated by multiplying the perimeter by the insulation depth and multiplying the result by 1/R. The Sum of the "Area X 1/R" column for the Floor is 124 for "Your House" and 135.3 for "Code House". The extra slab insulation, 6.0 is greater than the code-required 5.5, means that there is extra Area X 1/R which can help the other out-of-compliance elements.

If there were other components, the same procedure would be followed for them.

The Total Area X 1/R for "Your House" is 335.9 and for the "Code House" is 335.4. Since the total for "Your House" must be less than the total for "Code House", "Your House" is not in compliance. But, the difference is very small.

There are four choices to bring this residence into compliance, adding insulation to the roof, adding insulation to the walls, adding insulation to the slab perimeter, and reducing the area of glazing.

Let's say that the designer decides to modify the roof/ceiling insulation by increasing the roof/ceiling insulation from R-30 to R-38. This change yields a new roof/ceiling "System R_o" of 39.1 from the table on page A-2.

Crossing out the 31.1 and inserting 39.1 and performing the multiplication again yields a new "Area X 1/R_o" for the roof/ceiling of 32.4. Editing the Total at the bottom of the page, yields 327.6. This is now lower than the "Code House" total of 335.4, and the house is in compliance. No additional changes must be made.

EXAMPLE 1-C: ACCEPTABLE PRACTICE ANALYSIS OF 1-A

Code compliance using Acceptable Practice will now be determined for the single-family residence in Albuquerque.

Step 1: **Locate the appropriate detail and determine the U-value of the walls.**

A portion of Table 602.2.1a from the 1992 Model Energy Code Appendix is shown below for this example.

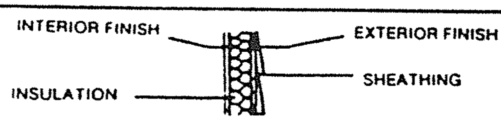
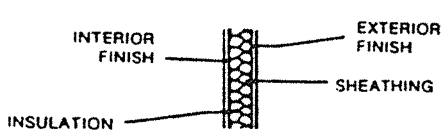
The interior finish of the example is gypboard. That is shown on 1. in the interior finish schedule. The example exterior finish is both stucco and brick veneer, shown as 1. and 3. in the exterior finish schedule. The illustrated wall detail is thus the correct one for this example house. The specified R-value of insulation in the example is R-11, so the U_w is 0.08.

Model E..gy Code

TABLE NO. 602.2.1a
WALL ASSEMBLIES

U_w selected shall not exceed the U_o determined by Section 602.2.1 for any wall section.

NOTE: Details shown are for insulation and are not complete construction details

Construction	WALL DETAILS		R VALUE OF INSULATION	U_w
	SCHEDULES TYP. INTERIOR FINISH: 1 GYPSUM WALLBOARD; 2 LATH & PLASTER; 3 ¼" MIN. WD. PANELING TYP. EXTERIOR FINISH: 1 STUCCO; 2 WD. OR PLYWD. SDG.; 3 BRICK VENEER		—	—
WOOD STUD CONSTRUCTION			11	.08 ←
			13	.07
			19	.05
STEEL STUD CONSTRUCTION		STUDS @ 16" O.C.	11	.14
			13	.13
			19	.11
		STUDS @ 24" O.C.	11	.12
			13	.11
			19	.10

NOTE: U_w calculated based on Standard RS-1 listed in Chapter 7.

Step 2: **Modify the U-value of the walls as necessary according to the amount of windows, doors, skylights, etc.**

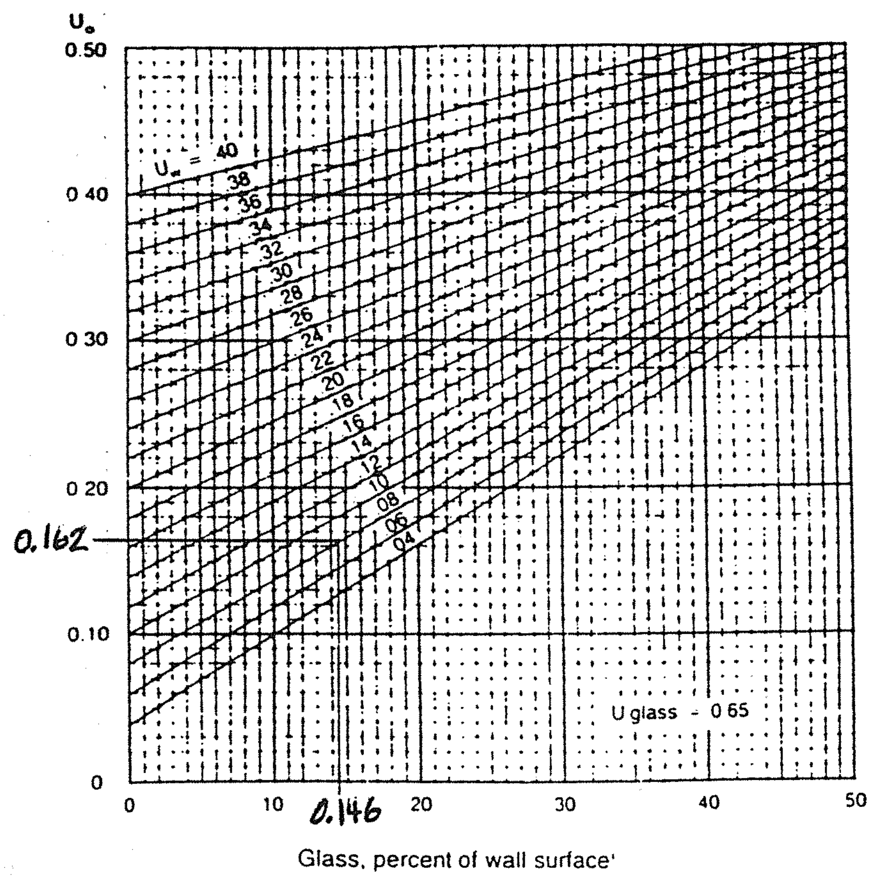
The windows of the house are specified as double-glazed insulating type. The window area is 134 sf, and the door area is 83 sf and the total wall area is 1,488 sf. Adding the opening areas together gives an area of 217 sf.

The percentage of wall area that is opening is (217/1,488) = 0.146. The U_w of 0.08, double glaze, and opening percent of 0.146 are utilized on Chart 6-B for U_w values for opaque walls below.

To utilize Chart 602.2.1b, you move to the right on the bottom scale to 0.146 (see arrow). Next move up to 0.08. Finally, move left to find 0.162 on the horizontal scale. This is the number that the Code sets as the maximum U_o.

CHART 602.2.1b

U_W VALUES FOR OPAQUE WALLS



Combinations of Wall and Double-glazed Openings for Use with Section 602.2.1

'The total area of opaque doors shall be included in the glazed opening area.

Step 3: **Compare the U-value with the Code requirements.**

From the Table in Appendix A, page A-1, the maximum U_o for walls in Albuquerque is 0.15. Since the modified U_o from the graph is 0.162, the walls of this house will " not pass" the Code.

<u>Remember, this methodology is more conservative than other procedures.</u>

Step 4: **Repeat Steps 1-3 for Roof/Ceiling**

The interior finish of the ceiling is also gypboard. This is shown as 1. in the interior finish schedule in Table 602.2.2 from the 1992 Model Energy Code shown below for roof/ceiling assemblies. The specified R-value of insulation in the example is R-30, so the U_r is 0.03.

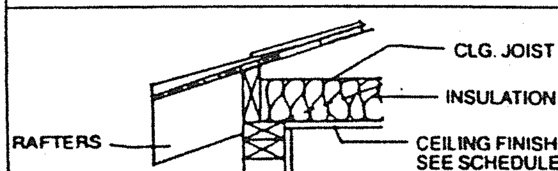
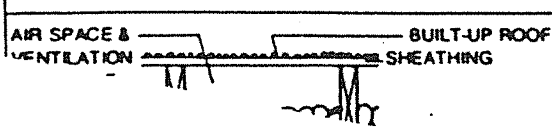
From the Table in Appendix B, the maximum U_r for roof/ceiling in Albuquerque is 0.034. The calculated U_r is 0.03. Being less, the ceiling will "pass" the Code.

Model Energy Code

TABLE NO. 602.2.2
ROOF/CEILINGS ASSEMBLIES

U_r selected shall not exceed the value specified in 602.2.2.

NOTE: Details shown are for insulation and are not complete construction details.

ROOF DETAILS	R VALUE OF INSULATION	U_r
TYPICAL INTERIOR FINISH SCHEDULE 1. GYPSUM WALLBOARD 2. LATH & PLASTER	———	——
	19 22 30 38	05 04 03 025
	19	.05
	22	.04
	30	.03
	[illegible]	025

Step 5: **Repeat Steps 1-3 for Floors**

The floor is unheated slab-on-grade. The R-valued specified in the plans is R-5.25. In Albuquerque, an unheated slab-on grade must have an R-value of 4.0. Since the specified R-value is greater than the Code, no calculation is necessary. If calculations were necessary, information would be obtained from Table 602.2.3 in the 1992 Model Energy Code Appendix illustrating floor assemblies.

Additional perimeter insulation would be required in cities such as Taos, Cuba, Cloudcroft, Chama, Eagle Nest and Tierra Amarilla.

Step 6: **Complete the Acceptable Practice Approach Form**

The results of the Acceptable Practice Approach are shown on the compliance form on the next page.

ACCEPTABLE PRACTICE COMPLIANCE

Walls

w/Single Glazing

1.	Gross Wall Area	_____SF
2.	Glazing Area	_____SF
3.	Door Area	_____SF
4.	Line 3 times 1/2	_____SF
5.	Line 2 + Line 4	_____SF
6.	Line 5 / Line 1	_____%
7.	U_w (wall detail)	_____
8.	U_o Wall (graph)	_____
9.	U_o Wall (Code)	_____

w/Double Glazing

1.	Gross Wall Area	1488 SF	
2.	Glazing Area	134 SF	
3.	Door Area	83 SF	
4.	Line 2 + Line 3	217 SF	
5.	Line 4 / Line 1	14.6 %	
6.	U_w (wall detail)	0.08	
7.	U_o Wall (graph)	0.162	
8.	U_o Wall (Code)	0.15	NOT PASS

Roof/Ceilings

1.	Gross Ceiling Area	_____SF	
2.	Glazing Area	_____SF	
3.	Line 2 / Line 1	_____*	
4.	U_r (Roof Detail)	0.03	
5.	U_o Roof (Code)	0.034	PASS

Floors Over Unheated Space

1.	Gross Floor Area	_____SF	
2.	U_f (floor detail)	_____	
3.	U_o Floor (Code)	_____	
	R-value	5.25	
	R-value (Code)	4.00	PASS

* If Line 3 under Roof/Ceilings is greater than 0.01, design cannot be complied with by the Acceptable Practice path.

EXAMPLE 2 SINGLE-FAMILY, TWO STORY RESIDENCE

We are going to calculate a **Sivage Thomas House** for two climate zones, Las Cruces and Farmington, in order to demonstrate the "Thermal Envelope Compliance Guide" compliance procedure for a two story, single family detached residence. This example has several steps which will assist in understanding the compliance procedures for more complex buildings. The completed Applications Worksheet appears along with the other results from this example.

EXAMPLE 2-A: SINGLE-FAMILY, TWO STORY RESIDENCE IN LAS CRUCES

Description of the House

Roof/Ceiling: Flat Ceiling (vented Attic) with area of 1159 sf and R-30 batts. Trusses 24 in. O.C. No skylights.

Openings: 291 sf of windows with R - 1.72 glazing. 56 sf of Doors with R-2.56 doors.

Walls: 2221 net sf with R-13 batts, non-insulated sheathing with 2X4 studs.

Floor: Lower level is slab, 136.5 ft. perimeter, R-4.0 with 24 in. depth. There is 247 sf area of the second floor over the unheated garage. This area has R-19 batts.

Step 0: General Information

Fill in the blanks at the top of the Applications Worksheet.

Job Location: Las Cruces, NM
Heating Degree Days: 3223 from A-1 in Appendix A.

EXAMPLE 2-A

Applications Worksheet

Builder Name: SIVAGE THOMAS Date 12-2-93
Address: 5141 MASTHEAD ST., ALBUQUERQUE, N.M.
Submitted by: BUILDER Phone:
Building Address: 1422 W 12 ST. LAS CRUCES, N.M.
Legal Descr. Lot: Section: County:
General Descr.
Local HDD 3223 Building Area: sf

Roof/Ceiling

Ceiling Type	Area, sf	R-value installed	System R_o From Page A-2	AreaX1/R_o	Meets MEC
Flat Ceiling	1159	30	31.1	37.3	
Cathedral Ceiling					
Totals, Total "Area" and "AreaX1/R_o" columns.	1159			37.3	
Required R_o from Appendix A-1, Compare to "Ave. R_o" If "Ave. R_o" is greater than Required R_o, check "Meets MEC" column.	25.4		Ave. R_o = Tot. "Area" ÷ "A X 1/R"	31.1	✓
Skylight Percent, must be less than 1%	0%				✓

Openings

Opening Type	Area	R-value From Page A-3	Area X 1/R
Window Type 1	291	1.72	169.2
Window Type 2			
Slider			
Basement Window			
Door	56	2.56	21.9
Open Area Total Sum the "Area" and "Area X 1/R" columns.	347		191.1
Glazing R_o Divide total "Area" by Total "A X 1/R"	1.82		

Step 1: Roof/Ceiling Areas

The house has a pitched roof and a vented attic. Since the attic is vented, the roof does not retard heat flow. Only the insulation on top of the ceiling and the ceiling itself will be used in the resistance calculations. The area of the roof is length times width. The roof area is 1159 sf. If all or a portion of a roof is cathedral type, assemblies values are available for those systems.

The roof/ceiling is insulated by R-30 batts, so write 30 in the "R-value Installed" box. Look up the "System R_o" on page A-2 of the Appendix. The trusses are 24 in. O.C. so the "System R_o" is 31.1. Place this value in the box. Multiply the "Area" by "1/System R_o" and place this number, 37.3, in the "Area X 1/R" column. Total the "Area" and "Area X 1/R_o" columns. Determine the "Ave R_o" by Multiplying the total "Area" by the Total "Area X 1/R" yielding 31.1. Note that since this example has only one ceiling type, the average is the same as the System R_o.

Look up the roof/ceiling R_o required, appearing on the Table in Appendix A-1, and shown below. For this case, Las Cruces, the R_o is 25.4. <u>The "System R_o" for the example house of 31.1 is greater than the required R_o of 25.4 so the roof is in compliance, place a check in the "Meets MEC" column.</u>

The house does not have skylights, so enter 0% in the box and check the compliance box.

Step 2: Openings

Determine the areas, manufacturers, and other information about the openings in the exterior walls. These simply must be measured from the plans for the house.

Element	Area, sf	R_o
Window, Type 1	291	1.72
Window, Type 2	0	
Slider Area	0	
Basement window	0	
Door Area	56	2.56

Multiply each area by "1/R-value" and insert the number in the "Area X 1/R" column. Total the "Area" and "Area X 1/R" columns. Divide the total opening area, 347, by the total of the "Area X 1/R" column, 191.1, and place the result, 1.82, in the "Glazing R_o" blank. This number represents an overall average of the R-values of all of the non-wall elements of the envelope.

Exterior Walls

				Meets MEC
Gross Wall Area	2221	Percent Open Divide the Open Area Total by the Gross Wall Area.	15.6%	
		Wall R-value Installed	13	
Wall R_o Required from Appendix A, Interpretive Requirements Tables. If "System R_o-value" is greater than "Wall R_o Required" Check "Meets MEC" column.	10.09	System R_o-value from Tables in Appendix A.	13.08	✓

Other Components

	Required From Tables in Appendix A.		Installed Value	System R_o From Tables in Appendix A.	Meets MEC
Floor R_o	20		19	20.1	✓
Slab Insulation R-value	4		4		✓
Slab Insulation depth	24"		24"		✓
Crawlspace R_o					
Basement R_o-value					
Other R_o					
Other R_o					

COMPLIANCE CERTIFICATION

This Residence Meets the 1992 Model Energy Code

Builder/Designer ____________________ Company Name ____________ Date ________

Building Official ____________________ Jurisdiction ____________ Date ________

Step 3: Exterior Walls

Calculate the gross wall area and place the number in the box. "Gross Wall Area" is 2221. Calculate the percent open by dividing the "Gross Wall Area" into the "Open Area Total" from the previous step.

For this example this is 347/2221 = 15.6%.

Determine the wall insulation to be installed, in this case, R-13. Using the Table found on page 16 of the Guide, locate the "System R_o" for the wall approximating that of this house. The best number is 13.08. Write this number in the "System R_o" box.

Now, find the Interpretive Requirements Table for this project. This means looking through the tables on pages A-4 through A-8 and finding the table for the HDD range including the HDD for the project site. For this project with HDD = 3223, the job table is the uppermost of the three tables on page A-6. The HDD can be located in the upper left corner of each table.

The Interpretive Requirements Table is used to establish the minimum R_o required for the opaque area of the wall. Enter the Table from the right using the glazing R_o determined in the preceding step, namely R_o = 1.82. Use the Row with R = 2.0. Read across the top of the Table until you get to the column with a percentage equal to or greater than the percent open calculated above. For this example, the percent column to use is the 16% column because it is the first column greater than 15.6%. Determine the number at the intersection of this column with the previously selected row.

The number is 10.09. This is the Code-required minimum R_o for the Opaque Wall Assembly and the value should be written in the "Wall R_o Required" box. Compliance for the wall exists because the system R_o of 13.08 is greater than the required R_o of 10.09. Place a check in the "Meets MEC" column next to the system R_o box.

Note, that if the wall being constructed does not meet this criterion, there are two ways to proceed.

First, using the Interpretive Requirements table, one can look at the possibility of reducing glazing by a percent or two to get the required Opaque Exterior Wall Assembly R-Value down to that of the planned wall assembly. Also, one can see what Glazing wall assembly R-value would make the wall comply. The Table gives the designer the power to choose simple the change to make to bring the wall/glazing assembly into compliance.

The second method of proceeding is to go to the "Trade Off Worksheet." Because the example wall is in compliance, the Trade Off Worksheet will not be needed here, but it will become necessary to use it later on.

Step 4: Other Components

The required values of the other components can be inserted into the blanks in the next box. There are spaces for required Floor R_o, Slab Perimeter R_o, Slab depth, Crawlspace R_o, Basement R_o, and other values. When one of these elements exists in the job, insert the number from the table selected from the Interpretive Requirements section.

The example has a second floor area located over the unheated garage. This means that a floor assembly check must be made. From the table on page A-1, the "Floor Over Unheated Spaces" minimum R_o is 20. Since the floor has R = 19 batts, the table on page A-2 indicates that the system R_o = 20.1. <u>This number is placed in the "System R_o" box and, since 20.1 exceeds 20, a check is placed in the "Meets MEC" column.</u>

The plans call for an unheated concrete slab-on-grade construction. Perimeter insulation with an R-value of 4 is specified. For this example, the slab floor is unheated, the insulation value is R-4, and the insulation extends down 24 in. Insert this information in the form.

The required slab perimeter R-value and slab perimeter insulation depth come from the Table on A-1 for Las Cruces. They are R= 4.00 and 24 in.

<u>The slab perimeter insulation complies in both R-value and depth. Place checks in the "Meets MEC" column for these two elements.</u>

<u>Example Summary</u>: **All elements of this house comply with the Thermal envelope requirements of the MEC. This completed form should be copied and turned in along with any plans submitted for permit. A copy should be kept so that an inspector who later visits the site can see these calculations, if requested.**

EXAMPLE 2-B: SINGLE FAMILY, TWO STORY RESIDENCE IN FARMINGTON

To continue with the demonstration of the compliance methodology in the "Thermal Envelope Compliance Guide," the Sivage Thomas house will be examined as though it were going to be constructed in Farmington instead of Las Cruces. Please note that all building measured calculations remain unchanged from the previous example, only the "required" values change due to the different climate factors.

Step 0: General Information

Fill in the blanks at the top of the Applications Worksheet.

Job Location:	Farmington, NM
Heating Degree Days:	5747 from A-1 in Appendix A.

Step 1: Roof/Ceiling Areas

The first step is to calculate the area of the roof, the installed R-value and the System R_o. These values were determined in the previous example, 1159 s.f., R=30.0, and 31.1 respectively.

Find the R_o required from page A-1, which for Farmington is 36.7. <u>This roof assembly does not comply, so do not put a check in the "Meets MEC" column.</u>

Step 2: Openings

The next step is to collect the information about the openings and insert it into the blanks in the Application Worksheet. This data was developed in the previous example: 291 sf of windows with R-value of 1.72 and 56 sf of door with R-value of 2.56. Completing the math steps yields a glazing system R of 1.82.

Step 3: Exterior Walls

All steps were completed in the previous example, except that the "Wall R_o required" is different for Farmington. Now using the Interpretive Requirements table for this site, located on page A-7. Going down the left side column to the nearest number to the glazing system R_o of 1.82 fixes us at the 2.0 row. The percent open area is 15.6%, so reading across to the column with the next larger value, 16% fixes the column. The number at the intersection of the row and column yields the minimum R_o for the Opaque wall area. For the example, this value is 18.58. This number is to be inserted in the "Wall R_o Required" block on the Applications Worksheet. The "System R_o" is 13.08. <u>Since this R_o-value is less than the required value, the wall does not comply and no check should be put in the "Meets MEC" column.</u>

EXAMPLE 2-B

Trade Off Worksheet

Builder Name: SIVAGE THOMAS Date 12-17-93
Address: 5141 MASTHEAD ST. ALBUQUERQUE, N.M.
Submitted by: BUILDER Phone:
Building Address: 14 APACHE DR. FARMINGTON, N.M.
Legal Descr.Lot: Section: County:
Local HDD 5747 Building Area: sf

YOUR HOUSE **CODE HOUSE**

Roof/Ceiling

	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$				
Ceiling/Attic	1159	~~31.1~~ 39.1	~~37.3~~ 29.6				
Cathedral							
Skylight							
Total	1159				Area	Required R from A-1	AreaX1/R
Total Area X 1/R Sum the "Area X $1/R_o$" Column			37.7		1159	36.7	31.6

Wall

Opening Type	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$				
Window, Type 1	291	1.72	169.2				
Window, Type 2							
Slider							
Basement Window							
Door	56	2.56	21.9				
Other		17.00	110.2				
Opaque Area	1874	~~13.08~~	~~143.3~~				
Total					Area	Required R From A-1	Area X 1/R
Total Area X 1/R			~~334.4~~ 301.3		2221	7.7	288.4

<u>Trade Off Worksheet</u>: The worksheet, shown on the adjacent page, will be filled out for the Farmington version of the Sivage House to determine how the designer can make changes to bring it into compliance.

Roof/Ceiling: First fill out the "Roof/Ceiling" box: The values for "Your House" are transferred from the Applications worksheet. The numbers for the "Code House" are the actual area and the Required R_o from Table A-1. The "Area X 1/R" for "Your House" is 37.7 and for "Code House" is 31.6.

Walls: Next fill out the columns in the "Wall" box. Transfer the values from the "Openings" and "Exterior Walls" boxes on the worksheet. Note that there is a line for "Opaque Area." The opaque wall area is the "Gross Wall Area" minus the "Total Open Area." For this example it is 2221 sf minus 347 sf which is 1874 sf. The R_o for the wall is the "System R_o" for the wall, 13.08. Multiply each Area times its "Area X 1/R" and add up the values. The total is 334.4. Do the same for the "Code House." Multiply the "Area" of 2221 sf by the 1/R yields 288.4.

Floor: Proceed to the "Floor" box. The example has a second floor area located over the unheated garage, the area is 247 sf. For "Your House" insert the "System R_o" of 20.1. For the "Code House" insert the value from A-1, the "Floor Over Unheated Spaces" of 20. The "Area X 1/R" is 12.3. Insert the Slab Perimeter, the depth in ft., and the installed R-value. For "Your House" these values are 136.5, 2, and 4 and for "Code House" these values are . The result of the calculation is 68.5 for "Your House" and 56.9 for "Code House." The total of the "Area X 1/R" is 80.6 for "Your House"" and 69.3 for "Code House."

There are no Basement Walls or Crawlspace Walls in this house, so no values need to be inserted.

Total the Box totals for the "Area X 1/R" columns to see if "Your House" has a lower total than "Code House." The totals for this example are 452.7 for "Your House" and 389.3 for "Code House." <u>The house does not comply because 452.7 is not less than 389.3.</u>

Now the designer must try to bring the building into compliance by making design changes. There are four choices to bring this residence into compliance, adding insulation to the roof, adding insulation to the walls, adding insulation to the slab perimeter, and reducing the area of glazing.

Floor

	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$		Area	R	Area X 1/R
Floor Over Crawlspace	247	20.1	12.3		247	20	12.4
Cantilevered Floor							
Slab Ht? Unht?							
Slab	Perim X Depth 136.5 x 2	R ~~4.0~~ 6.0	45.5 ~~68.3~~		PerimXDepth 136.5 x 2	R 4.8	56.9
Total Area X 1/R							69.3

Basement Wall

	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$		Area, sf	Required R From Code	Area X 1/R
Opaque Area			/				/

Crawlspace Wall

	Area, sf	R_o From Tables in Appendix A	Area X $1/R_o$		Area, sf	Required R From Code	Area X 1/R
Opaque Area			/				/

Totals, Roof/Clg, Walls, Floors, Basement Walls, Crawlspace Walls	389.1 ~~396.8~~ ~~419.6~~ ~~452.7~~		**Totals, Roof/Clg, Walls, Floors, Basement Walls, Crawlspace Walls**	389.3

If the total for YOUR HOUSE is less than the total for CODE HOUSE, your house is in compliance.

COMPLIANCE CERTIFICATION This Residence Meets the 1992 Model Energy Code

Builder/Designer ______ Company Name ______ Date ______

Building Official ______ Jurisdiction ______ Date ______

First try: Looking at the roof/ceiling, it is clear that we cannot make up the entire difference that we need in this assembly. There appears to be a possibility at the walls. Increasing the wall insulation from R-13 to R-15 and adding ½ in. foam brings the "System R_o" to 17.00 from the table on page A-2. Crossing out the 13.08 and inserting 17.00 and performing the multiplication again yields a new "Area X $1/R_o$" for the wall of 110.2. Editing the Total at the bottom of the page, yields 419.6. <u>This is still not lower than the "Code House" total of 389.3. Additional changes must be made.</u>

Second try: The next change to be considered is the Slab floor. Consider increasing the slab insulation R-value to 6.00. Editing the R-value allows the "Area X 1/R" to be changed to 45.5. Again, editing the Total at the bottom of the page, yields 396.8. <u>This is still not lower than the "Code House" total of 389.3. Additional changes must be made.</u>

Third try: The final change without a major design change is to increase the insulation in the ceiling space from R-30 to R-38. This allows the "System R_o" to be edited from 31.1 to 39.1 and the "Area X 1/R" to be changed from 37.3 to 29.6. Again, editing the Total at the bottom of the page, yields 389.1. <u>This is just lower than the "Code House" total of 389.3.</u> No additional changes must be made.

<u>Example Summary</u>: Increasing the Roof/Ceiling insulation from R-30 to R-38, increasing the wall insulation from R-13 to R-15 (and changing the sheathing), and increasing the slab R-value from 4 to 6 allows a Las Cruces House to be meet the Code in Farmington. The designer of the building would consider the economics of these changes and might wish to obtain code compliance through reductions in windows areas or other changes. This Trade Off Worksheet should be cleaned up and submitted with a corrected Applications Worksheet for compliance proof.

APPENDICES

RESIDENTIAL BUILDINGS IN NEW MEXICO
Minimum Ro Values allowed by Code

City	Heating Degree Days 65 F	Min Ro Roof/Clg	Min Ro Walls A-1	Min Ro Walls A-2	Min Ro Flrs Over Unheated Spaces	Floor Slabs Min Ro Heated	Floor Slabs Min Ro Unhtd.	Floor Slabs Insul Depth Inches
Alamogordo	3053	24.9	5.8	3.0	20	6.0	4.0	24
Albuquerque	4332	29.4	6.6	3.2	20	6.0	4.0	24
Artesia	3366	25.9	6.0	3.1	20	6.0	4.0	24
Carslbad	2813	24.2	5.7	3.0	20	6.0	4.0	24
Carrizozo	4234	29.0	6.5	3.2	20	6.0	4.0	24
Chama	8254	38.5	9.1	4.3	20	8.8	6.5	48
Clayton	5150	33.2	7.2	3.4	20	6.5	4.4	24
Cloudcroft	7205	38.5	9.1	3.9	20	8.0	5.8	48
Clovis	4033	28.2	6.4	3.2	20	6.0	4.0	24
Corona	5389	34.6	7.4	3.5	20	6.7	4.6	24
Cuba	7122	38.5	9.1	3.9	20	8.0	5.7	48
Deming	3347	25.8	6.0	3.1	20	6.0	4.0	24
Eagle Nest	9254	38.5	9.1	4.6	20	9.6	7.2	48
Espanola	5641	36.1	7.6	3.5	20	6.9	4.8	24
Farmington	5747	36.7	7.7	3.6	20	6.9	4.8	24
Fort Sumner	3799	27.3	6.3	3.1	20	6.0	4.0	24
Gallup	6207	38.5	8.2	3.7	20	7.3	5.1	48
Glenwood	3632	26.8	6.2	3.1	20	6.0	4.0	24
Grants	6143	38.5	8.1	3.7	20	7.2	5.1	48
Hobbs	2954	24.6	5.8	3.0	20	6.0	4.0	24
Jemez Springs	5260	33.8	7.3	3.4	20	6.6	4.5	24
Las Cruces	3223	25.4	5.9	3.0	20	6.0	4.0	24
Las Vegas	5738	36.7	7.7	3.6	20	6.9	4.8	24
Lordsburg	3213	25.4	5.9	3.0	20	6.0	4.0	24
Los Alamos	6381	38.5	8.4	3.7	20	7.4	5.2	48
Magdalena	5074	32.8	7.1	3.4	20	6.4	4.4	24
Mescalero	5540	35.5	7.5	3.5	20	6.8	4.7	24
Mountainair	5558	35.6	7.6	3.5	20	6.8	4.7	24
Portales	3845	27.5	6.3	3.2	20	6.0	4.0	24
Raton	6001	38.5	8.0	3.6	20	7.1	5.0	48
Reserve	5483	35.1	7.5	3.5	20	6.7	4.7	24
Roswell	3565	26.5	6.1	3.1	20	6.0	4.0	24
Ruidoso	6309	38.5	8.3	3.7	20	7.4	5.2	48
Santa Fe	6001	38.5	8.0	3.6	20	7.1	5.0	48
Santa Rosa	3749	27.2	6.2	3.1	20	6.0	4.0	24
Silver City	4438	29.9	6.7	3.3	20	6.0	4.0	24
Socorro	3984	28.0	6.4	3.2	20	6.0	4.0	24
Springer	5653	36.1	7.6	3.5	20	6.9	4.8	24
T or C	3394	26.0	6.0	3.1	20	6.0	4.0	24
Taos	6827	38.5	8.9	3.8	20	7.7	5.5	48
Tierra Amarilla	7901	38.5	9.1	4.2	20	8.6	6.3	48
Tucumcari	3767	27.2	6.2	3.1	20	6.0	4.0	24
Tularosa	3056	24.9	5.8	3.0	20	6.0	4.0	24
Zuni	5742	36.7	7.7	3.6	20	6.9	4.8	24

HDD	R_o-VAL	R_o-VAL	R_o-VAL
3001-	ROOF: 26.32	UNHEATED SLAB: 4.00(24")	CRAWL WALL: 9.52
3500	FLOOR: 20.00	HEATED SLAB: 6.00(24")	BSMT WALL: 8.13

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	14.23	16.71	20.34	26.16							
1.5 (0.67)	9.32	9.90	10.57	11.36	12.30	13.44	14.84	16.62	18.95	22.13	26.73
2.0 (0.5)	7.95	8.22	8.52	8.85	9.22	9.63	10.09	10.61	11.19	11.87	12.65
2.5 (0.4)	7.30	7.46	7.63	7.82	8.02	8.23	8.46	8.71	8.99	9.28	9.61
3.0 (0.33)	6.93	7.03	7.14	7.25	7.38	7.50	7.64	7.79	7.94	8.11	8.28
3.5 (0.29)	6.68	6.75	6.82	6.90	6.98	7.06	7.15	7.24	7.33	7.43	7.54
4.0 (0.25)	6.51	6.56	6.60	6.65	6.71	6.76	6.81	6.87	6.93	7.00	7.06

HDD	R_o-VAL	R_o-VAL	R_o-VAL
3501-	ROOF: 28.09	UNHEATED SLAB: 4.00(24")	CRAWL WALL: 11.11
4000	FLOOR: 20.00	HEATED SLAB: 6.00(24")	BSMT WALL: 8.92

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	16.17	19.50	24.68								
1.5 (0.67)	10.11	10.81	11.63	12.61	13.80	15.27	17.15	19.61	23.00	27.95	
2.0 (0.5)	8.52	8.84	9.20	9.60	10.04	10.54	11.10	11.75	12.49	13.35	14.38
2.5 (0.4)	7.78	7.97	8.17	8.39	8.63	8.89	9.17	9.47	9.80	10.17	10.57
3.0 (0.33)	7.36	7.48	7.61	7.75	7.89	8.05	8.21	8.39	8.57	8.77	8.99
3.5 (0.29)	7.08	7.16	7.25	7.34	7.44	7.54	7.64	7.75	7.87	7.99	8.12
4.0 (0.25)	6.89	6.94	7.00	7.06	7.13	7.19	7.26	7.34	7.41	7.49	7.57

HDD	R_o-VAL	R_o-VAL	R_o-VAL
4001-	ROOF: 30.12	UNHEATED SLAB: 4.00(24")	CRAWL WALL: 13.13
4500	FLOOR: 20.00	HEATED SLAB: 6.00(24")	BSMT WALL: 10.00

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	18.73	23.39									
1.5 (0.67)	11.06	11.91	12.93	14.17	15.72	17.69	20.30	23.91			
2.0 (0.5)	9.18	9.57	10.00	10.48	11.02	11.64	12.35	13.17	14.13	15.27	16.65
2.5 (0.4)	8.33	8.55	8.80	9.06	9.34	9.65	9.99	10.37	10.78	11.24	11.76
3.0 (0.33)	7.85	7.99	8.14	8.31	8.48	8.67	8.87	9.08	9.31	9.56	9.83
3.5 (0.29)	7.53	7.63	7.74	7.84	7.96	8.08	8.21	8.34	8.49	8.64	8.80
4.0 (0.25)	7.31	7.38	7.45	7.53	7.61	7.69	7.77	7.86	7.96	8.06	8.16

HDD	R_o-VAL	R_o-VAL	R_o-VAL
4501-	ROOF: 32.47	UNHEATED SLAB: 4.33(24")	CRAWL WALL: 16.67
5000	FLOOR: 20.00	HEATED SLAB: 6.38(24")	BSMT WALL: 10.10

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	22.26										
1.5 (0.67)	12.20	13.26	14.56	16.18	18.26	21.02	24.88				
2.0 (0.5)	9.95	10.42	10.94	11.53	12.21	12.99	13.90	14.97	16.26	17.83	19.78
2.5 (0.4)	8.96	9.23	9.52	9.84	10.19	10.57	10.99	11.46	11.98	12.57	13.24
3.0 (0.33)	8.40	8.58	8.76	8.96	9.17	9.40	9.64	9.91	10.19	10.51	10.84
3.5 (0.29)	8.05	8.16	8.29	8.42	8.56	8.71	8.87	9.04	9.21	9.40	9.60
4.0 (0.25)	7.80	7.88	7.97	8.06	8.16	8.26	8.36	8.48	8.59	8.72	8.85

HDD	-R_o-VAL	R_o-VAL	R_o-VAL
5001-	ROOF: 35.21	UNHEATED SLAB: 4.76(24")	CRAWL WALL: 16.67
5500	FLOOR: 20.00	HEATED SLAB: 6.76(24")	BSMT WALL: 10.31

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	27.42										
1.5 (0.67)	13.60	14.96	16.66	18.85	21.78	25.89					
2.0 (0.5)	10.87	11.44	12.08	12.83	13.69	14.70	15.90	17.35	19.15	21.41	24.37
2.5 (0.4)	9.70	10.02	10.37	10.76	11.19	11.67	12.20	12.80	13.48	14.25	15.14
3.0 (0.33)	9.05	9.26	9.48	9.72	9.98	10.26	10.57	10.90	11.26	11.66	12.09
3.5 (0.29)	8.63	8.78	8.93	9.09	9.26	9.45	9.64	9.85	10.07	10.31	10.57
4.0 (0.25)	8.35	8.45	8.56	8.67	8.79	8.92	9.05	9.19	9.34	9.49	9.66

HDD	R_o-VAL	R_o-VAL	R_o-VAL
5501-	ROOF: 38.46	UNHEATED SLAB: 5.00(24")	CRAWL WALL: 16.67
6000	FLOOR: 20.00	HEATED SLAB: 7.14(24")	BSMT WALL: 10.42

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)											
1.5 (0.67)	15.37	17.15	19.46	22.57	26.97						
2.0 (0.5)	11.97	12.67	13.49	14.45	15.57	16.93	18.58	20.64	23.28	26.81	
2.5 (0.4)	10.56	10.96	11.40	11.88	12.42	13.03	13.72	14.51	15.41	16.46	17.69
3.0 (0.33)	9.79	10.05	10.33	10.62	10.95	11.30	11.69	12.11	12.57	13.09	13.66
3.5 (0.29)	9.31	9.49	9.68	9.88	10.09	10.32	10.57	10.83	11.11	11.42	11.75
4.0 (0.25)	8.98	9.11	9.24	9.38	9.53	9.69	9.86	10.03	10.22	10.42	10.64

HDD	R_o-VAL	R_o-VAL	R_o-VAL
6001-	ROOF: 38.46	UNHEATED SLAB: 5.33(48")	CRAWL WALL: 16.67
6500	FLOOR: 20.00	HEATED SLAB: 7.52(48")	BSMT WALL: 10.52

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)											
1.5 (0.67)	17.67	20.10	23.40								
2.0 (0.5)	13.31	14.22	15.28	16.54	18.06	19.95	22.34	25.45			
2.5 (0.4)	11.60	12.09	12.64	13.26	13.96	14.75	15.67	16.73	17.98	19.47	21.27
3.0 (0.33)	10.68	11.00	11.34	11.71	12.12	12.57	13.07	13.62	14.23	14.92	15.70
3.5 (0.29)	10.11	10.33	10.56	10.81	11.08	11.37	11.68	12.02	12.39	12.79	13.23
4.0 (0.25)	9.72	9.88	10.04	10.22	10.41	10.61	10.82	11.05	11.29	11.55	11.83

HDD	R_o-VAL	R_o-VAL	R_o-VAL
6501-	ROOF: 38.46	UNHEATED SLAB: 5.67(48")	CRAWL WALL: 16.67
7000	FLOOR: 20.00	HEATED SLAB: 7.90(48")	BSMT WALL: 10.63

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)											
1.5 (0.67)	20.77	24.27									
2.0 (0.5)	15.00	16.18	17.60	19.33	21.50	24.29					
2.5 (0.4)	12.86	13.48	14.19	15.00	15.93	17.00	18.26	19.76	21.58	23.82	26.67
3.0 (0.33)	11.74	12.14	12.57	13.05	13.58	14.17	14.82	15.56	16.40	17.36	18.46
3.5 (0.29)	11.05	11.33	11.62	11.94	12.29	12.66	13.07	13.51	14.00	14.54	15.14
4.0 (0.25)	10.59	10.79	11.00	11.23	11.47	11.72	12.00	12.30	12.62	12.96	13.33

The above table for 6501 - 7000 HDD applies to climates up to 9000 HDD with the following values for slab, and basement walls.

HDD	Unheated Slab (48")	Heated Slab (48")	Bsmt Walls
7001 - 7500	6.00	8.28	10.89
7501 - 8000	6.33	8.66	10.99
8001 - 8500	6.67	9.03	11.11
8501 - 9000	7.00	9.41	16.67

DEFINITIONS

AIR CONDITIONING. The process of treating air so as to control simultaneously its temperature, humidity, cleanliness, and distribution to meet requirements of the conditioned space.

AUTOMATIC. Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature, or mechanical configuration.

BRITISH THERMAL UNIT (Btu). The Btu has become the primary unit of energy use comparison. A Btu is defined as the amount of heat necessary to raise the temperature of one pound of water 1 deg. F from 59.5 deg. F to 60.5 deg. F at sea level. A Btu therefore represents a relatively small amount of energy.

DEGREE DAY, HEATING. A unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65 deg. F, there exists as many Degree Days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65 deg.

ENERGY. The capacity for doing work taking a number of forms which may be transformed from one into another, such as thermal (heat), mechanical (work), electrical, and chemical; in customary units, measured in kilo-Watt-hours (kWhr or KWH) or British thermal units (Btu).

ENERGY EFFICIENCY RATIO (EER). The ratio of net cooling capacity in Btu/hr to total rate of electric input in Watts under designated operating conditions.

EXTERIOR ENVELOPE. The elements of a building which enclose conditioned spaces through which thermal energy may be transferred to or from the exterior.

GROSS FLOOR AREA. The sum of areas of the several floors of the building, including basements, cellars, mezzanine and intermediate floored tiers and penthouses, measured from the exterior faces of exterior walls, or from the center line of walls separating buildings (outside dimensions). Covered walkways, open roofed-over areas, porches, and similar spaces shall be excluded. The gross floor area does not include such features as pipe trenches, exterior terraces or steps, chimneys, roof overhangs, etc.

GROSS WALL AREA. The normal projection of the exterior wall area bounding interior space which is conditioned by an energy-using system; includes opaque wall, window and door areas.

HEATED SLAB. A floor slab in which duct work for heating or heating coils are located.

HEATED SPACE. A space within a building which is provided with a positive heat supply to maintain air temperature of 50 deg. F or higher.

HVAC. Heating, ventilating, and air conditioning.

HVAC SYSTEM. A system that provides either collectively or individually the process of comfort heating, ventilating, and/or air conditioning within or associated with a building.

INFILTRATION. The uncontrolled inward air leakage through cracks and spaces in any building element (e.g., around windows and doors of a building) caused by pressure effects from differences in the indoor and outdoor air density.

KILOWATT HOUR (kWhr or KWH). This is the a unit of electrical consumption. It represents the use of 1,000 Watts (1 kilowatt) of power for one hour (e.g., burning ten 100 Watt lightbulbs for one hour). Lightbulbs and most appliances are rated in Watts. Motors typically draw 746 Watts per horsepower. A kiloWatt hour is equal to 3,413 Btus.

NONDEPLETABLE ENERGY SOURCES. Sources of energy (excluding minerals) derived from incoming solar radiation, including photosynthetic processes; from conditions including wind, waves and tides, lake or pond thermal differences; and energy derived from the internal heat of the earth, including thermal exchanges.

OPAQUE AREA. All exposed areas of a building envelope which enclose conditioned space except openings for windows, skylights, doors, and building service systems.

RESIDENTIAL BUILDING. Living unit of one story, two stories, or other low-rise, single and multifamily dwelling, not exceeding three stories above grade (Group R buildings).

ROOF ASSEMBLY. A roof assembly shall be considered as all components of the roof/ceiling envelope through which heat flows thereby creating a building transmission heat loss or gain where such assembly is exposed to outdoor air and encloses a heated or mechanically cooled space. The gross area of a roof assembly consists of the total interior surface of such assembly, including skylights, exposed to the heated or mechanically cooled space.

THERMAL RESISTANCE - R-VALUE. A measure of ability to retard heat flow rather than ability to transmit heat. R is the numerical reciprocal of U, thus $R = 1/U$. R is used in combination with numerals to designate thermal resistance units: R-11 equals 11 resistance units. The higher the R, the higher the insulating factor. All insulation products having the same R, regardless of material and thickness, are equal in insulating value.

THERMAL TRANSMITTANCE - U-VALUE. Coefficient of heat transmission normally expressed in units of Btu per hour per square foot per degree F.It is the time rate of heat flow. The U-value applies to combinations of different materials used in series along the heat flow path, such as individual materials that comprise a building section, cavity air spaces, and surface air film on both sides of a building element.

THERMAL TRANSMITTANCE - Uo-VALUE. Overall (average) heat transmission of a gross area of the exterior building envelope, expressed in units of Btu per hour per square foot per degree F. The Uo-value applies to the combined effect of the time rate of heat flows through the various parallel paths such as windows, doors and opaque construction areas, comprising the gross area of one or more exterior building components, such as walls, floors, or roof/ceiling.

UNHEATED SLAB. A floor slab in which no heating duct work or heating coils are run.

WEIGHTED AVERAGE. When one needs to determine the overall effect of R-value when there are several R-values in a wall or roof, one combines them by weighted average. The resulting R-value is a fictitious R-value and that weighted average R-value has the same effect as the combination of R-values actually being installed. This weighted average is developed by multiplying each R-value by its area and adding these together. The resulting sum is divided by the entire area (the sum of the individual areas).

ZONE. A space or group of spaces within a building with heating or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

SELECTED R-VALUES OF COMMON BUILDING MATERIALS

Insulation

Batt/Blanket - Mineral Fiber	R-3.50 per inch
Expanded Polystyrene - Molded Bead	R-3.85 - 4.35 per inch
Cellular Polyurethane	R-6.25 per inch
Loose Fill Mineral Fiber	R-3.00 per inch
Loose Fill Cellulose	R-3.70 per inch
Vermiculite (expanded)	R-2.27 per inch
Cellular Polyisocyanurate	R-7.20 per inch

Wood

Hard Woods	R-0.90 per inch
Soft Woods	R-1.25 per inch
Plywood	R-1.24 per inch
Hardboard - Medium Density	R-1.37 per inch
Particle Board - Medium Density	R-1.06 per inch

Building Board/Siding

15# Permeable Felt	R-0.06
Gypboard	R-0.90 per inch
Insulating Board Sheathing 18#	R-2.64 per inch
Wood Shingle, 16 in., 7 1/2 in. Exposure	R-0.87
Wood Siding, 1/2 in. x 8 in. Lapped	R-0.81

Masonry

Common Brick	R-0.20 per inch
Face Brick	R-0.11 per inch
Stone	R-0.08 per inch
Stucco/Plaster	R-0.20 per inch
Concrete Block 8" Density 75	R-1.11
Cinder Block 8" Density 75	R-1.72
Adobe - 10-inch thick	R-2.78
Adobe - 14-inch thick	R-3.89

Roofing

Built Up - 3/8 inch	R-0.33
Asphalt - Roll	R-0.15
Asphalt Shingles	R-0.44

Flooring

Tile - Asphalt, Linoleum, Vinyl	R-0.05
Carpet - Fibrous Pad	R-2.08
- Rubber Pad	R-1.23

Glass - Vertical	Unshaded Winter	Unshaded Summer
Single	U-1.10	U-1.04
Double 1/4" air space	U-0.58	U-0.61
1/2" air space	U-0.49	U-0.56
Triple 1/4" air space	U-0.39	U-0.44
1/2" air space	U-0.31	U-0.39
Storm Windows		
1" to 4" air space	U-0.50	U-0.50

Glass - Horizontal	Winter	Summer
Single	U-1.23	U-0.83
Double 1/4" air space	U-0.65	U-0.54
1/2" air space	U-0.59	U-0.49

Plastic Bubble

Single Walled	U-1.15	U-0.80
Double Walled	U-0.70	U-0.46

Doors	Winter	Summer		
	No Storm	Wood Storm	Metal Storm	No Storm
Solid Wood 2-1/4"	U-0.27	U-0.20	U-0.21	U-0.26
1-3/4"	U-0.33	U-0.28	U-0.25	U-0.32
1-3/8"	U-0.39	U-0.26	U-0.28	U-0.38
Steel - 1-3/4" Foam Core with Thermal Break	U-0.19	U-0.16	U-0.17	U-0.18
Core without Thermal Break	U-0.40	-	-	U-0.39

Surface Air Films	
Inside Still Air	
Heat Flow Up Nonreflective (ceilings)	R-0.61
Heat Flow Down Nonreflective (floors)	R-0.92
Heat Flow Horizontal Nonreflective (walls)	R-0.68
Outside	
Heat Flow Any Direction	
15 mph Any Surface Position - Winter	R-0.17
7 1/2 mph Any Surface Position - Summer	R-0.25

Shading Coefficients	Without Draperies	With Venetian Blinds
Single Glass		
1/4" Regular	0.95	0.64
1/2" Regular	0.88	0.64
1/4" Heat Absorbing	0.73	0.57
3/8" Heat Absorbing	0.64	0.54
1/2" Heat Absorbing	0.58	0.42
Reflective Coated Glass	0.60	0.50
(See Manufacturers'	0.50	0.42
Literature for	0.40	0.33
Exact Values)	0.30	0.25
Double Glass		
1/4" Regular	0.83	0.57
1/4" Heat Absorbing	0.55	0.39

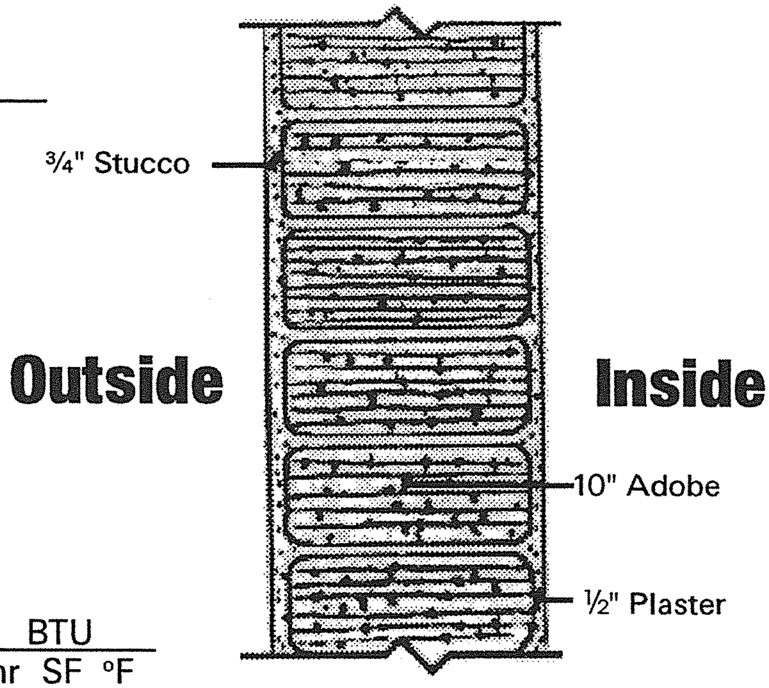
APPENDIX D

Illustrations of these wall sections and their Effective U-Values are found on the following pages.

LIST OF EFFECTIVE U-VALUE WALL SECTIONS
CONVENTION: OUTSIDE-INSIDE

Wall No.	Description
1	3/4" stucco; 10" adobe; 1/2" plaster
2	3/4" stucco; 14" adobe; 1/2" plaster
3	3/4" stucco; l" polystyrene; 10" adobe; 1/2" plaster
4	3/4" stucco; l" polystyrene; 14" adobe; 1/2" plaster
5	3/4" stucco; 2" polystyrene; 14" adobe; 1/2" plaster
6	3/4" stucco; 10" adobe; 2" batt; 1/2" plaster
7	3/4" stucco; 10" adobe; 2" batt; 1/2" gyp board
8	3/4" stucco; 14" adobe; 3-1/2" batt; 1/2" gyp board
9	8" light wt. block, unfilled; paint
10	8" standard conc. block, unfilled, paint
11	8" light wt. block, vermiculite fill; paint
12	8" standard conc. block, unfilled; 3-1/2" batt; 1/2" board
13	6" thru wall brick, unfilled
14	8" thru wall brick, unfilled
15	6" thru wall brick, vermiculite fill
16	8" thru wall brick, vermiculite fill
17	Brick veneer; 3/4" air space; 1/2" fiberboard; 2x4 studs; full 3-1/2" batt; 1/2" gyp board
18	Brick veneer; 3/4" air space; 1/2" fiberboard; 2x4 studs; 2" batt; 1/2" gyp board
19	l" stucco; 1/2" fiberboard; 2x4 studs; no insulation; 1/2" gyp board
20	l" stucco; 1/2" fiberboard; 2x4 studs; 3-1/2" batt; 1/2" gyp board
21	1" stucco; 1/2" fiberboard; 2x4 studs; 3-1/2" batt; 1/2" gyp board
22	l" stucco; 1/2" fiberboard; 2x6 studs; 6" batt; 1/2" gyp board
23	Brick veneer; 3/4" air space; 1/2" fiberboard; 2x6 studs; 6" batt; 1/2" gyp board
24	Brick veneer; 3/4" air space; technifoam; 2x4 studs; 3-1/2" batt; 1/2" gyp board
25	l" stucco; l" technifoam; 2x4 studs; 3-1/2" batt; 1/2" gyp board
26	7-1/4" x 8-1/2" pine logs with splines

WALL TYPE 1



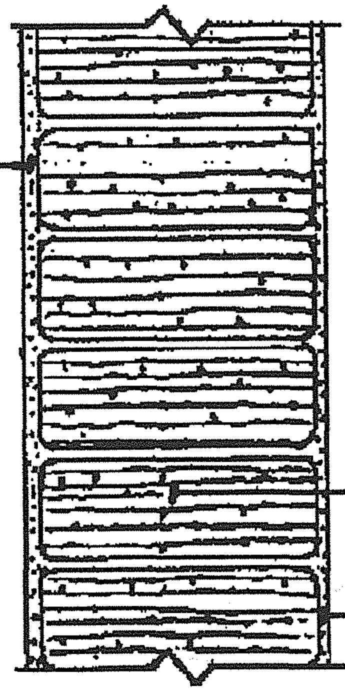
ASHRAE STEADY STATE U= VALUE 0.263 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.260	.225	.191	.252	.205	.160	.244	.188	.138	.254	.210	.168
2	.237	.219	.200	.231	.205	.179	.225	.189	.155	.233	.208	.184
3	.232	.218	.203	.227	.204	.182	.220	.187	.156	.228	.208	.187
4	.230	.218	.207	.224	.203	.183	.215	.181	.149	.225	.206	.188
5	.230	.219	.207	.223	.202	.182	.214	.179	.145	.225	.206	.187
6	.231	.220	.208	.224	.202	.179	.214	.176	.139	.226	.206	.186
7	.234	.221	.209	.225	.201	.176	.214	.172	.131	.227	.205	.183
8	.238	.224	.209	.228	.199	.171	.215	.166	.119	.231	.205	.179
9	.244	.227	.209	.232	.198	.164	.217	.160	.105	.235	.204	.174
10	.255	.232	.209	.240	.195	.152	.221	.150	.082	.243	.204	.165
11	.262	.235	.208	.245	.194	.144	.244	.143	.067	.249	.203	.159

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 2



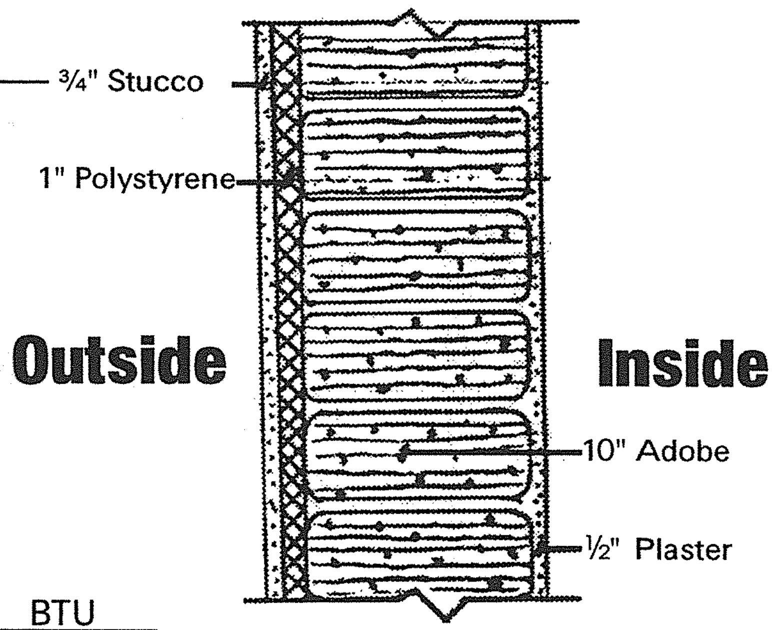
ASHRAE STEADY STATE U= VALUE 0.203 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
	Wall Orientation											
N.M. Climatic Region	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.210	.185	.161	.204	.170	.138	.198	.157	.120	.206	.175	.144
2	.187	.174	.161	.183	.164	.146	.178	.152	.128	.184	.167	.150
3	.182	.172	.162	.179	.162	.147	.173	.150	.127	.180	.165	.150
4	.180	.171	.163	.175	.161	.146	.169	.145	.122	.176	.163	.150
5	.180	.172	.164	.175	.160	.145	.168	.144	.119	.176	.163	.150
6	.181	.173	.165	.176	.160	.144	.168	.141	.115	.177	.163	.149
7	.184	.175	.166	.178	.160	.142	.169	.139	.110	.179	.163	.148
8	.188	.177	.167	.181	.160	.140	.171	.136	.103	.182	.164	.146
9	.193	.181	.169	.185	.160	.136	.174	.133	.094	.187	.165	.144
10	.204	.187	.171	.193	.161	.130	.180	.129	.080	.196	.168	.141
11	.211	.192	.173	.199	.162	.126	.184	.126	.071	.202	.170	.138

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 3



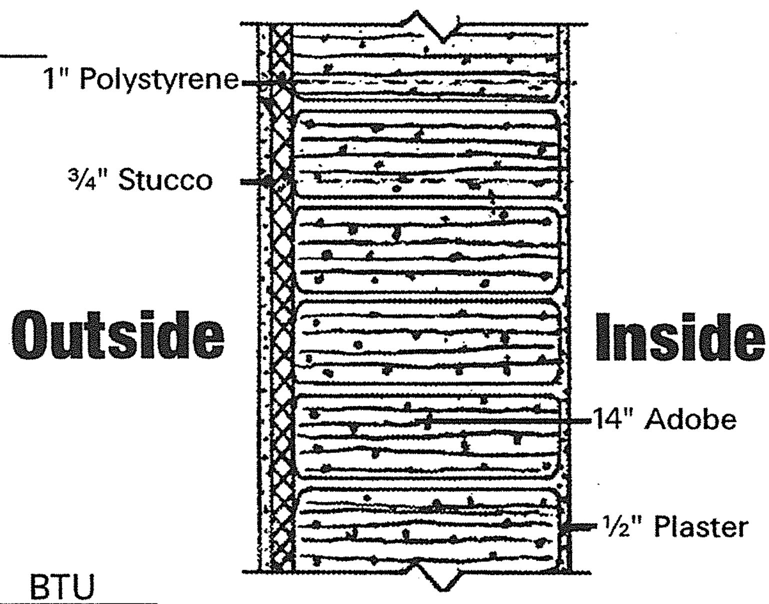
ASHRAE STEADY STATE U= VALUE 0.110 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.118	.104	.091	.114	.096	.078	.112	.089	.069	.116	.099	.083
2	.104	.097	.090	.102	.091	.081	.099	.085	.072	.102	.093	.084
3	.101	.095	.090	.099	.090	.081	.096	.083	.071	.100	.092	.084
4	.099	.095	.090	.097	.089	.081	.093	.081	.068	.098	.091	.084
5	.100	.095	.091	.097	.089	.081	.093	.080	.067	.098	.091	.084
6	.100	.096	.091	.097	.089	.080	.093	.079	.065	.098	.091	.083
7	.102	.097	.092	.098	.089	.079	.094	.078	.062	.099	.091	.083
8	.104	.099	.093	.100	.089	.078	.095	.076	.058	.101	.092	.082
9	.108	.101	.094	.103	.090	.076	.097	.075	.054	.104	.093	.082
10	.114	.105	.096	.108	.095	.074	.101	.073	.047	.110	.095	.080
11	.119	.108	.098	.112	.092	.072	.104	.072	.042	.114	.096	.080

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 4



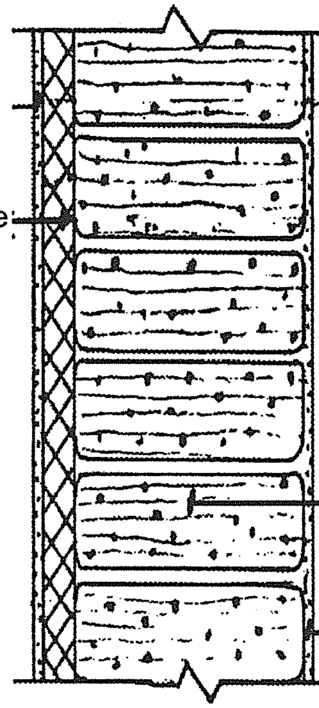
ASHRAE STEADY STATE U= VALUE 0.098 $\frac{\text{BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.105	.096	.086	.103	.090	.077	.101	.085	.069	.104	.092	.080
2	.091	.086	.081	.089	.082	.074	.087	.077	.067	.090	.083	.076
3	.088	.084	.080	.086	.080	.073	.084	.075	.066	.087	.081	.076
4	.086	.083	.080	.084	.078	.073	.082	.072	.063	.085	.080	.075
5	.086	.083	.080	.084	.078	.072	.082	.072	.062	.085	.080	.075
6	.087	.084	.081	.085	.078	.072	.082	.071	.061	.086	.080	.075
7	.088	.085	.081	.086	.079	.072	.083	.071	.060	.087	.081	.075
8	.091	.087	.083	.088	.080	.072	.084	.071	.058	.089	.082	.075
9	.095	.090	.085	.091	.081	.072	.087	.071	.055	.092	.084	.076
10	.101	.095	.088	.097	.084	.071	.092	.071	.052	.098	.087	.077
11	.106	.098	.091	.101	.086	.071	.095	.072	.050	.102	.090	.078

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 5



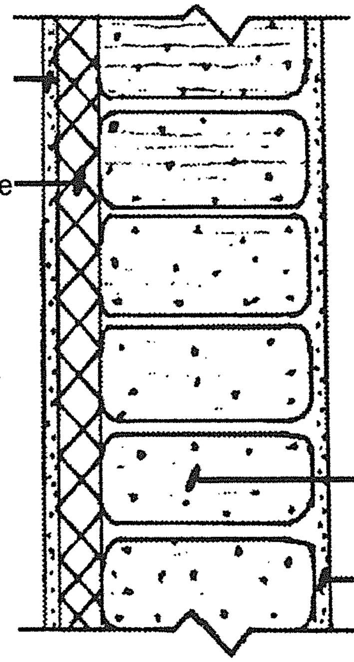
ASHRAE STEADY STATE U= VALUE 0.065 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
	Wall Orientation											
N.M. Climatic Region	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.070	.064	.058	.068	.060	.052	.067	.057	.047	.069	.061	.054
2	.059	.056	.053	.058	.054	.049	.057	.051	.045	.059	.055	.051
3	.057	.055	.052	.056	.052	.048	.055	.049	.044	.057	.053	.050
4	.056	.054	.052	.055	.051	.048	.053	.048	.042	.055	.052	.049
5	.056	.054	.052	.055	.051	.048	.053	.047	.042	.055	.052	.049
6	.057	.055	.053	.055	.051	.047	.054	.047	.041	.056	.053	.049
7	.058	.055	.053	.056	.052	.047	.054	.047	.040	.057	.053	.049
8	.059	.057	.054	.058	.053	.048	.055	.047	.039	.058	.054	.050
9	.062	.059	.056	.060	.054	.048	.057	.047	.038	.060	.055	.051
10	.066	.062	.059	.064	.056	.048	.061	.048	.037	.065	.058	.052
11	.069	.065	.060	.066	.057	.049	.063	.049	.036	.067	.060	.053

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 6



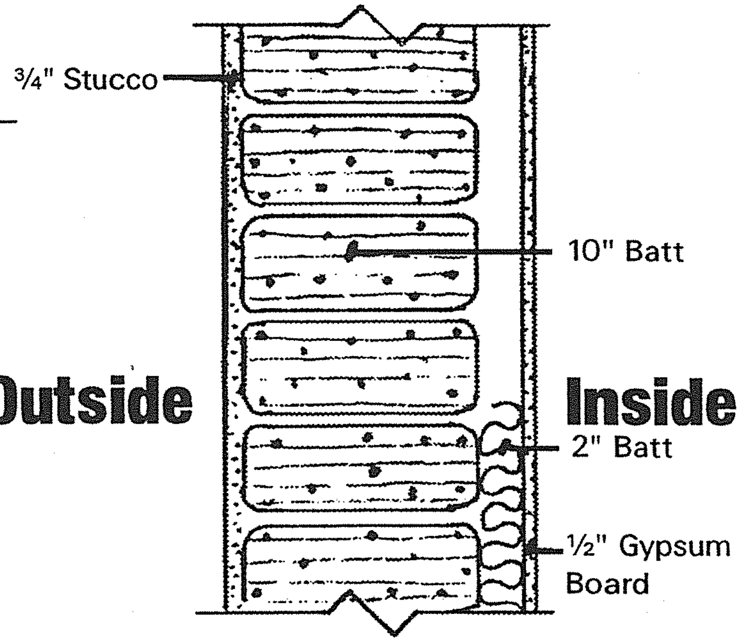
ASHRAE STEADY STATE U= VALUE $\frac{0.070 \text{ BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.075	.067	.059	.073	.062	.051	.072	.058	.045	.074	.064	.054
2	.066	.062	.057	.064	.058	.052	.063	.054	.046	.065	.059	.054
3	.064	.061	.057	.063	.057	.052	.061	.053	.046	.063	.058	.054
4	.063	.060	.057	.061	.056	.052	.059	.051	.044	.062	.058	.053
5	.063	.060	.058	.061	.056	.051	.059	.051	.043	.062	.058	.053
6	.063	.061	.058	.062	.056	.051	.059	.050	.042	.062	.058	.053
7	.064	.061	.059	.062	.056	.051	.060	.050	.040	.063	.058	.053
8	.066	.063	.059	.064	.057	.050	.061	.049	.038	.064	.059	.053
9	.068	.064	.060	.066	.057	.049	.062	.049	.036	.066	.060	.053
10	.073	.067	.062	.069	.058	.048	.065	.048	.032	.070	.061	.052
11	.076	.069	.063	.072	.059	.047	.067	.048	.029	.073	.062	.052

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 7



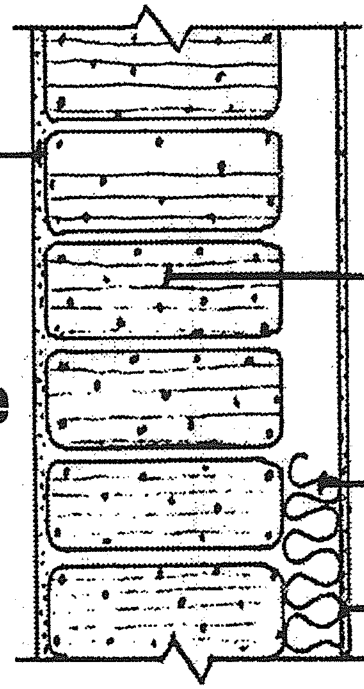
ASHRAE STEADY STATE U= VALUE 0.124

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	0.140	0.124	0.107	0.135	0.114	0.091	0.131	0.104	0.078	0.136	0.116	0.096
2	0.124	0.116	0.107	0.122	0.109	0.097	0.118	0.101	0.085	0.122	0.111	0.100
3	0.121	0.115	0.108	0.119	0.108	0.098	0.115	0.100	0.085	0.119	0.110	0.100
4	0.119	0.114	0.109	0.117	0.107	0.097	0.112	0.097	0.082	0.117	0.109	0.100
5	0.120	0.114	0.109	0.117	0.107	0.097	0.112	0.096	0.080	0.117	0.109	0.100
6	0.121	0.115	0.110	0.117	0.107	0.096	0.112	0.095	0.077	0.118	0.109	0.099
7	0.122	0.116	0.111	0.118	0.107	0.095	0.113	0.093	0.074	0.119	0.109	0.099
8	0.125	0.118	0.112	0.121	0.107	0.094	0.114	0.091	0.069	0.122	0.110	0.098
9	0.129	0.121	0.113	0.124	0.107	0.091	0.116	0.084	0.063	0.125	0.111	0.096
10	0.136	0.125	0.115	0.129	0.108	0.087	0.120	0.086	0.530	0.131	0.112	0.094
11	0.141	0.128	0.116	0.133	0.109	0.085	0.123	0.084	0.047	0.135	0.114	0.092

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 8



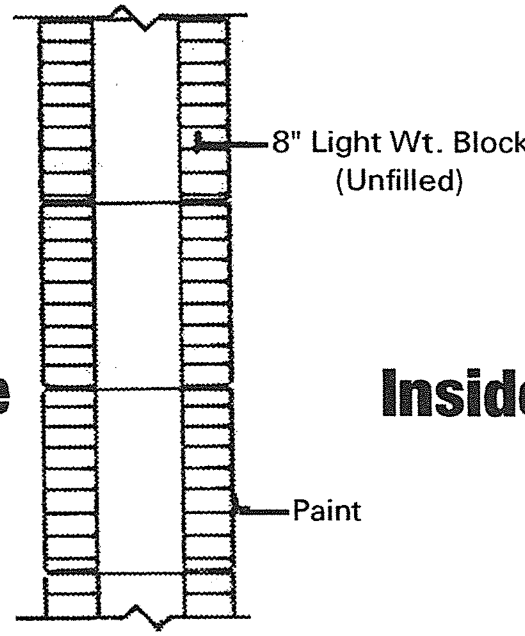
ASHRAE STEADY STATE U= VALUE 0.068 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.089	.082	.074	.087	.077	.067	.086	.073	.060	.088	.078	.069
2	.076	.072	.068	.075	.069	.063	.074	.066	.058	.075	.070	.065
3	.074	.071	.067	.072	.068	.063	.071	.064	.057	.073	.068	.064
4	.072	.070	.067	.071	.066	.062	.069	.062	.055	.071	.067	.063
5	.072	.070	.067	.071	.066	.062	.069	.061	.054	.071	.067	.063
6	.073	.070	.068	.071	.066	.062	.069	.061	.053	.072	.068	.063
7	.074	.072	.069	.072	.067	.062	.070	.061	.052	.073	.068	.064
8	.077	.073	.070	.074	.068	.062	.072	.061	.051	.075	.070	.064
9	.080	.076	.072	.077	.070	.062	.074	.061	.049	.078	.072	.065
10	.086	.081	.076	.082	.073	.063	.078	.063	.047	.083	.075	.067
11	.090	.084	.078	.086	.075	.063	.082	.063	.046	.087	.077	.068

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 9



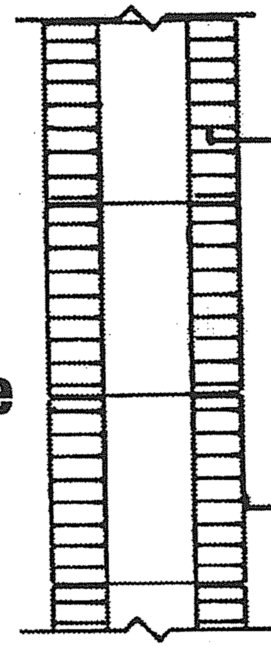
ASHRAE STEADY STATE U= VALUE $\frac{0.314 \text{ BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.290	.234	.175	.277	.202	.119	.264	.158	.052	.279	.201	.124
2	.275	.245	.214	.266	.223	.179	.255	.194	.133	.268	.226	.185
3	.272	.247	.223	.263	.226	.190	.252	.198	.145	.265	.231	.197
4	.270	.250	.232	.260	.226	.195	.246	.195	.143	.262	.233	.204
5	.270	.251	.232	.259	.225	.193	.245	.191	.137	.262	.232	.203
6	.270	.251	.232	.258	.222	.188	.243	.185	.125	.262	.230	.199
7	.272	.251	.231	.258	.219	.181	.241	.176	.109	.262	.228	.193
8	.274	.250	.227	.258	.212	.168	.238	.162	.083	.263	.222	.181
9	.278	.249	.221	.259	.204	.150	.236	.145	.049	.264	.215	.165
10	.284	.247	.210	.260	.190	.119	.232	.115	-008	.267	.203	.136
11	.284	.245	.201	.262	.181	.097	.231	.096	-047	.269	.194	.117

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 10



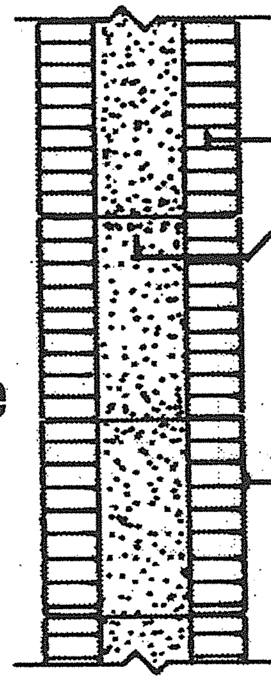
ASHRAE STEADY STATE U= VALUE $\frac{0.525 \text{ BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
	Wall Orientation											
N.M. Climatic Region	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.442	.374	.306	.427	.339	.246	.414	.291	.158	.431	.339	.249
2	.417	.381	.344	.407	.355	.303	.394	.320	.245	.409	.359	.310
3	.412	.383	.353	.402	.357	.312	.388	.322	.257	.404	.362	.322
4	.408	.384	.361	.396	.354	.314	.379	.322	.252	.399	.363	.327
5	.408	.385	.362	.395	.352	.311	.377	.310	.245	.399	.362	.326
6	.409	.385	.361	.394	.348	.305	.374	.302	.231	.398	.359	.321
7	.411	.385	.360	.394	.344	.296	.372	.292	.213	.399	.356	.314
8	.414	.385	.356	.394	.337	.282	.369	.277	.183	.400	.350	.301
9	.419	.384	.350	.395	.328	.262	.367	.258	.145	.403	.343	.284
10	.428	.383	.338	.399	.313	.228	.365	.226	.080	.408	.331	.252
11	.435	.382	.330	.402	.303	.205	.364	.205	.036	.412	.322	.231

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 11



ASHRAE STEADY STATE U= VALUE 0.170 BTU / hr SF °F

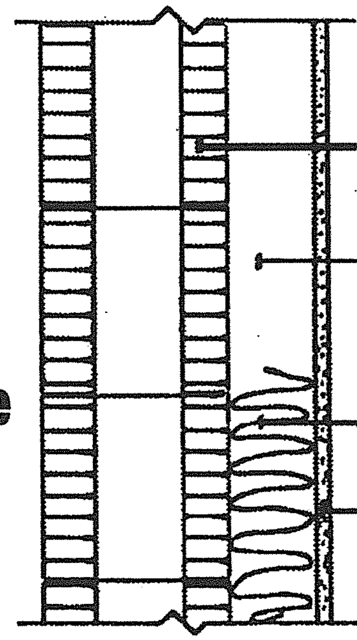
EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.171	.138	.105	.163	.120	.076	.157	.101	.041	.166	.125	.082
2	.161	.144	.127	.156	.131	.107	.150	.116	.081	.158	.135	.111
3	.160	.145	.132	.155	.133	.112	.148	.117	.086	.156	.136	.117
4	.159	.148	.137	.153	.133	.114	.145	.114	.084	.154	.137	.120
5	.159	.148	.137	.153	.133	.113	.144	.112	.081	.154	.136	.119
6	.160	.148	.137	.153	.131	.111	.143	.108	.075	.155	.136	.117
7	.161	.149	.137	.153	.129	.107	.142	.104	.066	.155	.134	.114
8	.163	.149	.135	.154	.126	.100	.141	.096	.053	.156	.132	.108
9	.166	.149	.132	.155	.122	.090	.141	.088	.036	.158	.129	.100
10	.171	.148	.127	.157	.115	.074	.140	.073	.006	.160	.123	.086
11	.174	.148	.122	.158	.110	.062	.139	.063	-014	.153	.119	.077

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 12

Outside



Inside

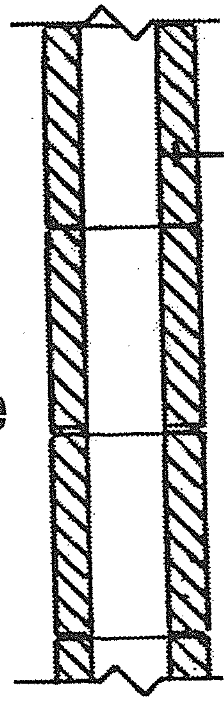
ASHRAE STEADY STATE U= VALUE $\frac{0.084 \text{ BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.094	.080	.066	.091	.072	.054	.088	.064	.040	.092	.074	.056
2	.087	.080	.073	.085	.075	.064	.083	.068	.054	.086	.076	.066
3	.086	.080	.075	.084	.075	.066	.081	.068	.055	.085	.076	.068
4	.086	.081	.076	.083	.075	.067	.080	.067	.054	.084	.076	.069
5	.086	.081	.077	.083	.075	.066	.080	.066	.052	.084	.076	.069
6	.086	.082	.077	.083	.074	.065	.079	.064	.050	.084	.076	.068
7	.087	.082	.077	.084	.074	.064	.079	.063	.046	.085	.076	.067
8	.089	.083	.077	.085	.073	.061	.079	.060	.041	.086	.075	.065
9	.090	.083	.077	.086	.072	.058	.080	.057	.034	.087	.075	.063
10	.094	.085	.075	.088	.070	.052	.081	.052	.023	.089	.074	.058
11	.096	.085	.075	.090	.069	.048	.081	.048	.015	.091	.073	.054

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 13



ASHRAE STEADY STATE U= VALUE 0.472 BTU / hr SF °F

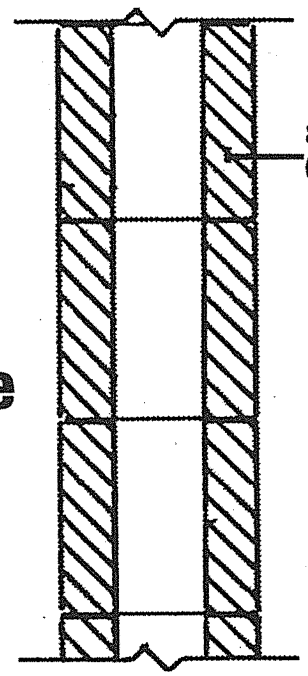
EFFECTIVE "U" - VALUE (U_E): HEATING

N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.421	.360	.300	.408	.328	.246	.397	.284	.163	.412	.330	.246
2	.394	.361	.328	.384	.337	.290	.373	.305	.237	.387	.341	.296
3	.388	.361	.334	.378	.337	.298	.366	.306	.248	.381	.343	.306
4	.384	.362	.341	.372	.334	.298	.357	.299	.244	.375	.342	.311
5	.384	.362	.341	.371	.333	.296	.355	.295	.237	.375	.341	.309
6	.385	.363	.341	.371	.330	.291	.353	.288	.225	.375	.340	.305
7	.387	.363	.340	.371	.326	.283	.351	.280	.209	.376	.337	.299
8	.391	.364	.338	.373	.321	.271	.350	.267	.183	.378	.333	.289
9	.396	.365	.334	.375	.314	.255	.350	.252	.151	.382	.328	.275
10	.407	.366	.326	.381	.303	.227	.350	.226	.094	.389	.320	.250
11	.415	.367	.320	.385	.296	.208	.351	.209	.057	.394	.314	.232

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 14



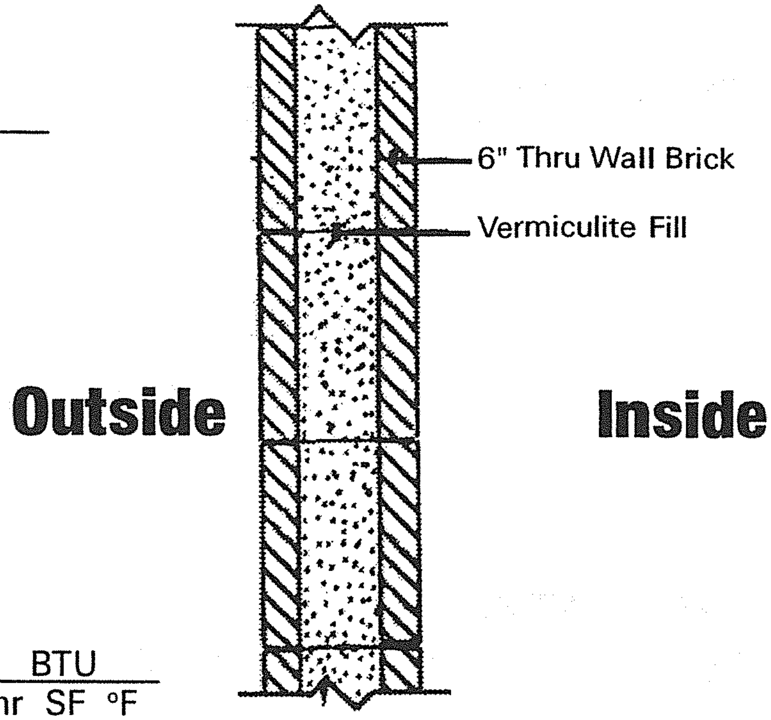
ASHRAE STEADY STATE U= VALUE 0.439 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.399	.341	.284	.386	.310	.231	.375	.269	.160	.389	.311	.235
2	.371	.340	.310	.362	.318	.274	.352	.288	.226	.365	.322	.281
3	.366	.341	.316	.357	.318	.281	.345	.289	.235	.359	.323	.289
4	.362	.341	.322	.351	.316	.282	.337	.283	.230	.354	.323	.293
5	.362	.342	.322	.350	.314	.280	.335	.279	.224	.354	.322	.292
6	.363	.342	.322	.350	.312	.275	.333	.272	.213	.354	.321	.288
7	.365	.343	.322	.350	.308	.268	.332	.265	.197	.355	.319	.283
8	.369	.344	.320	.352	.303	.257	.331	.253	.173	.357	.315	.273
9	.375	.345	.316	.355	.298	.242	.331	.238	.143	.361	.311	.260
10	.386	.347	.309	.361	.288	.216	.332	.214	.091	.368	.303	.237
11	.393	.349	.304	.365	.281	.198	.334	.198	.057	.374	.298	.221

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 15



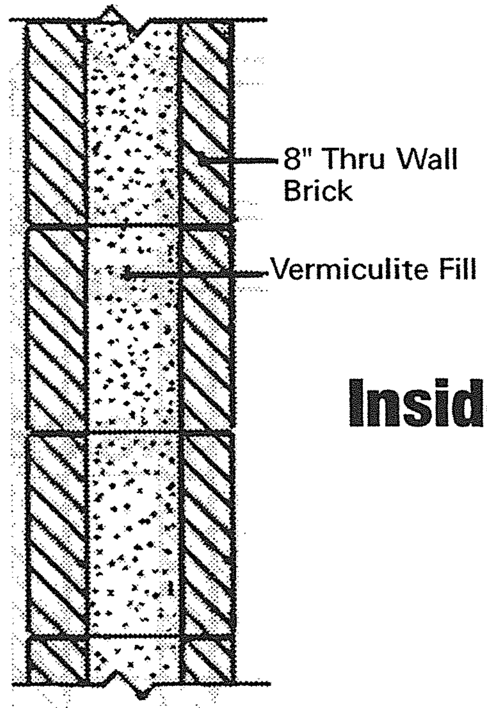
ASHRAE STEADY STATE U= VALUE $\frac{0.271 \text{ BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
	Wall Orientation											
N.M. Climatic Region	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.249	.212	.177	.240	.193	.149	.234	.176	.106	.243	.200	.153
2	.233	.213	.194	.227	.199	.173	.221	.183	.142	.229	.204	.177
3	.230	.214	.198	.224	.200	.177	.217	.182	.147	.226	.204	.182
4	.228	.215	.203	.221	.199	.177	.212	.177	.143	.223	.203	.184
5	.228	.216	.203	.221	.198	.175	.211	.174	.140	.223	.202	.183
6	.229	.216	.203	.221	.197	.172	.210	.170	.133	.223	.201	.181
7	.231	.217	.203	.222	.195	.168	.210	.168	.124	.224	.200	.177
8	.234	.218	.202	.223	.192	.161	.209	.158	.110	.226	.198	.172
9	.238	.218	.200	.225	.188	.152	.209	.150	.093	.228	.196	.165
10	.245	.220	.195	.229	.181	.136	.210	.136	.063	.233	.192	.151
11	.250	.220	.192	.232	.177	.126	.211	.127	.043	.237	.189	.142

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 16



ASHRAE STEADY STATE U= VALUE 0.211 BTU / hr SF °F

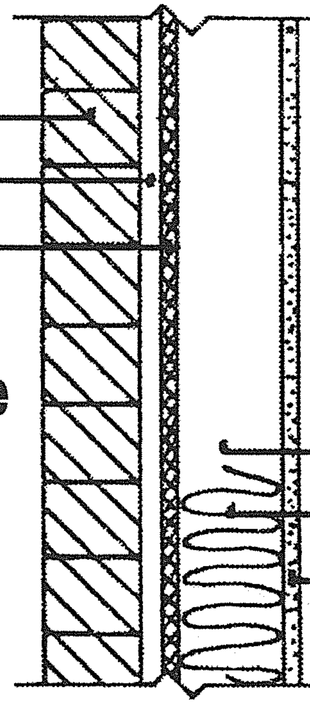
EFFECTIVE "U" - VALUE (U_E): HEATING

N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.200	.170	.141	.193	.154	.118	.187	.143	.093	.195	.159	.125
2	.186	.170	.155	.181	.159	.132	.176	.146	.116	.182	.162	.142
3	.183	.171	.158	.179	.160	.141	.173	.146	.118	.180	.162	.145
4	.182	.172	.162	.176	.159	.141	.169	.141	.114	.178	.162	.146
5	.182	.172	.162	.176	.158	.140	.168	.139	.111	.178	.162	.146
6	.183	.173	.163	.176	.157	.138	.168	.136	.106	.178	.161	.144
7	.184	.173	.162	.177	.166	.135	.167	.132	.099	.179	.160	.142
8	.187	.174	.162	.178	.154	.130	.167	.127	.088	.180	.159	.137
9	.190	.175	.160	.180	.151	.123	.168	.120	.075	.183	.157	.132
10	.197	.177	.158	.184	.147	.110	.169	.110	.053	.187	.154	.122
11	.201	.178	.155	.187	.144	.102	.170	.103	.039	.191	.152	.116

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 17



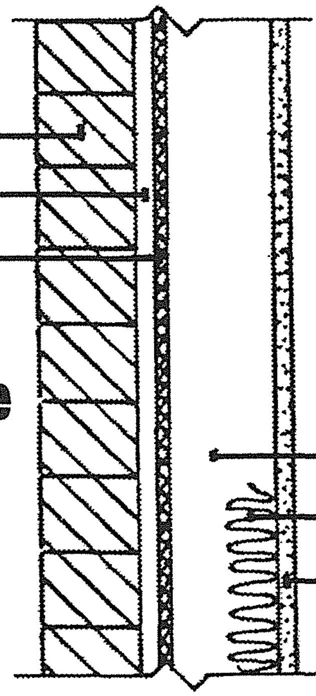
ASHRAE STEADY STATE U= VALUE 0.075 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.084	.071	.058	.081	.063	.046	.078	.056	.032	.082	.065	.048
2	.078	.071	.065	.076	.066	.057	.074	.060	.047	.077	.068	.058
3	.077	.072	.066	.075	.067	.058	.073	.061	.048	.076	.068	.060
4	.077	.072	.068	.074	.067	.059	.071	.059	.047	.075	.068	.061
5	.077	.072	.068	.074	.067	.059	.071	.059	.046	.075	.068	.061
6	.077	.073	.068	.074	.066	.058	.071	.057	.044	.075	.068	.061
7	.078	.073	.069	.075	.066	.057	.071	.056	.041	.076	.068	.060
8	.079	.074	.068	.076	.065	.054	.071	.053	.036	.076	.067	.058
9	.081	.074	.068	.077	.064	.051	.071	.050	.029	.078	.066	.055
10	.084	.075	.066	.078	.062	.045	.072	.045	.018	.080	.065	.050
11	.086	.076	.066	.080	.060	.041	.072	.042	.011	.081	.064	.047

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 18



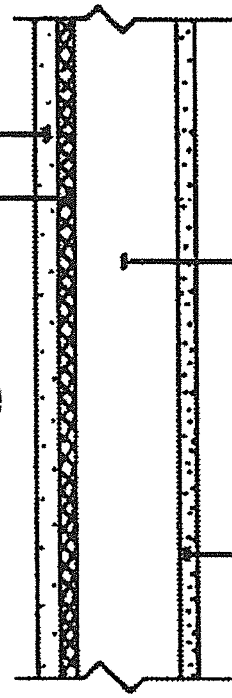
ASHRAE STEADY STATE U= VALUE 0.095 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.105	.088	.072	.101	.079	.057	.098	.069	.040	.102	.081	.059
2	.097	.089	.080	.095	.082	.070	.092	.075	.058	.095	.084	.072
3	.096	.089	.082	.093	.083	.073	.090	.075	.060	.094	.084	.075
4	.095	.090	.084	.092	.083	.073	.088	.073	.059	.093	.084	.076
5	.095	.090	.085	.092	.082	.073	.088	.072	.057	.093	.084	.076
6	.096	.090	.085	.092	.082	.072	.088	.071	.054	.093	.084	.075
7	.096	.091	.085	.093	.081	.070	.087	.069	.050	.094	.084	.074
8	.098	.091	.084	.093	.080	.067	.087	.066	.044	.095	.083	.071
9	.100	.092	.084	.094	.079	.063	.088	.062	.036	.096	.082	.068
10	.103	.093	.082	.097	.076	.056	.088	.056	.022	.098	.080	.062
11	.106	.093	.081	.098	.074	.051	.089	.052	.013	.100	.079	.058

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 19



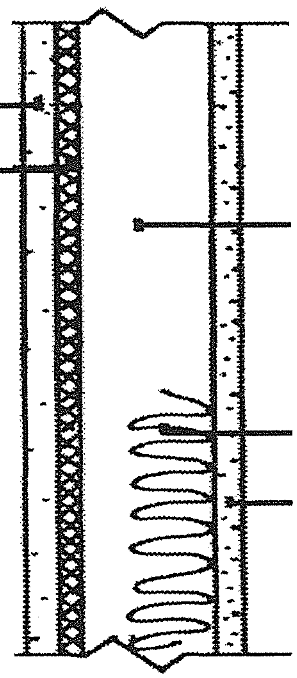
ASHRAE STEADY STATE U= VALUE 0.269 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.272	.231	.188	.262	.209	.146	.255	.172	.097	.265	.205	.148
2	.255	.232	.210	.248	.217	.183	.241	.193	.150	.250	.218	.188
3	.251	.233	.215	.245	.217	.190	.237	.196	.158	.246	.221	.196
4	.249	.234	.220	.241	.216	.192	.231	.193	.155	.243	.222	.201
5	.249	.235	.221	.241	.215	.191	.230	.191	.151	.243	.221	.200
6	.250	.235	.221	.240	.213	.183	.229	.186	.143	.243	.220	.198
7	.251	.235	.220	.241	.211	.183	.227	.180	.131	.244	.219	.193
8	.254	.236	.219	.242	.207	.174	.227	.171	.113	.245	.216	.186
9	.257	.236	.216	.243	.202	.163	.226	.160	.090	.248	.212	.176
10	.265	.237	.210	.246	.194	.142	.226	.141	.051	.252	.205	.157
11	.269	.237	.205	.249	.189	.128	.227	.128	.024	.256	.201	.144

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 20



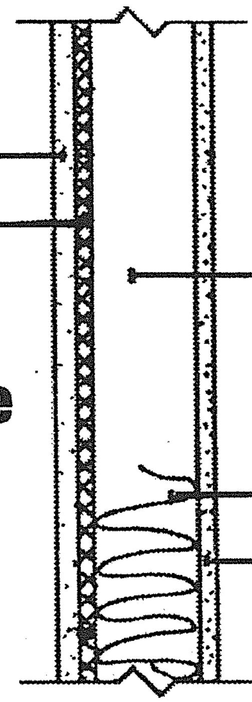
ASHRAE STEADY STATE U= VALUE 0.106 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
	Wall Orientation											
N.M. Climatic Region	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.117	.099	.080	.113	.088	.063	.109	.076	.045	.114	.090	.060
2	.109	.100	.090	.106	.093	.079	.103	.084	.065	.107	.094	.082
3	.108	.100	.093	.105	.093	.082	.102	.085	.068	.106	.095	.085
4	.107	.101	.095	.104	.093	.083	.100	.083	.067	.105	.095	.086
5	.107	.101	.095	.104	.093	.082	.099	.082	.065	.105	.095	.086
6	.108	.102	.096	.104	.092	.081	.099	.080	.062	.105	.095	.085
7	.109	.102	.095	.104	.091	.079	.099	.078	.057	.105	.094	.084
8	.110	.102	.095	.105	.090	.075	.098	.074	.050	.106	.094	.081
9	.112	.103	.094	.106	.088	.071	.098	.070	.041	.108	.092	.077
10	.116	.104	.092	.108	.085	.062	.099	.062	.025	.110	.090	.070
11	.118	.104	.090	.109	.083	.056	.099	.057	.015	.112	.088	.065

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 21



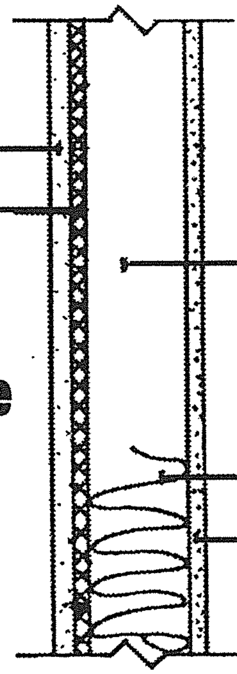
ASHRAE STEADY STATE U= VALUE 0.080 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.089	.075	.061	.086	.067	.048	.083	.059	.035	.087	.069	.051
2	.084	.076	.069	.081	.071	.060	.079	.064	.050	.082	.072	.063
3	.082	.077	.071	.080	.071	.062	.078	.065	.052	.081	.073	.065
4	.082	.077	.073	.079	.071	.063	.076	.063	.051	.080	.073	.066
5	.082	.077	.073	.079	.071	.063	.076	.063	.050	.080	.073	.066
6	.082	.078	.073	.080	.071	.062	.076	.061	.047	.080	.073	.065
7	.083	.078	.073	.080	.070	.060	.075	.059	.044	.081	.072	.064
8	.084	.079	.073	.080	.069	.058	.075	.057	.038	.082	.072	.062
9	.086	.079	.072	.081	.068	.054	.076	.053	.032	.083	.071	.059
10	.089	.080	.070	.083	.065	.048	.076	.048	.020	.085	.069	.054
11	.091	.080	.069	.084	.064	.043	.076	.044	.012	.086	.068	.050

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 22



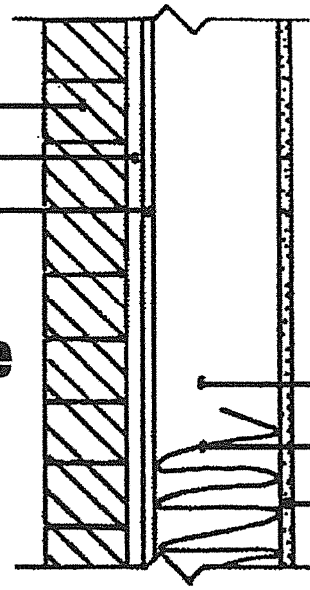
ASHRAE STEADY STATE U= VALUE 0.054 BTU / hr SF °F

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.062	.052	.043	.060	.047	.034	.058	.041	.025	.060	.048	.036
2	.058	.053	.048	.056	.049	.042	.054	.044	.035	.057	.050	.043
3	.057	.053	.049	.055	.049	.043	.054	.045	.036	.056	.050	.045
4	.056	.053	.050	.055	.049	.044	.053	.044	.035	.055	.050	.046
5	.057	.053	.050	.055	.049	.044	.052	.043	.034	.055	.050	.045
6	.057	.054	.051	.055	.049	.043	.052	.042	.033	.055	.050	.045
7	.057	.054	.051	.055	.048	.042	.052	.041	.030	.056	.050	.044
8	.058	.054	.050	.056	.048	.040	.052	.039	.027	.056	.050	.043
9	.060	.055	.050	.056	.047	.038	.052	.037	.022	.057	.049	.041
10	.062	.055	.049	.058	.045	.033	.053	.033	.014	.059	.048	.038
11	.063	.056	.048	.059	.044	.030	.053	.031	.009	.060	.048	.035

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 23



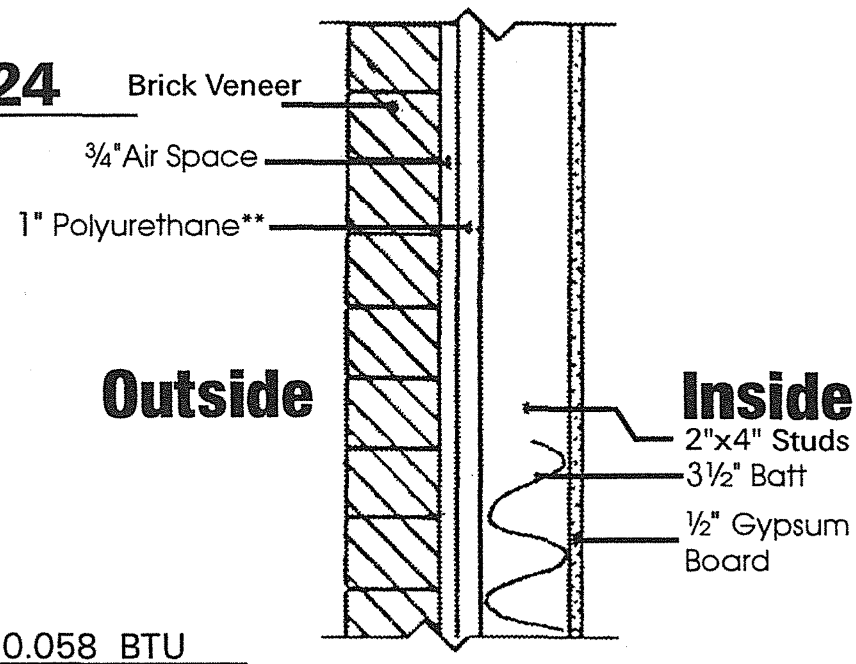
ASHRAE STEADY STATE U= VALUE $\frac{0.052\ \text{BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.060	.051	.042	.058	.046	.033	.056	.040	.024	.058	.047	.035
2	.055	.050	.046	.054	.047	.040	.052	.043	.033	.054	.048	.041
3	.054	.051	.047	.053	.047	.041	.051	.043	.034	.053	.048	.043
4	.054	.051	.048	.052	.047	.042	.050	.042	.034	.053	.048	.043
5	.054	.051	.048	.052	.047	.042	.050	.041	.033	.053	.048	.043
6	.054	.051	.048	.052	.047	.041	.050	.040	.031	.053	.048	.043
7	.055	.052	.048	.053	.046	.040	.050	.039	.029	.053	.048	.042
8	.056	.052	.048	.053	.046	.038	.050	.038	.025	.054	.047	.041
9	.057	.053	.048	.054	.045	.036	.050	.036	.021	.055	.047	.039
10	.060	.053	.047	.056	.044	.032	.051	.032	.014	.057	.046	.036
11	.061	.054	.047	.057	.043	.030	.052	.030	.009	.058	.046	.034

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 24



**1" Polyurethane with aluminum foil on both sides.

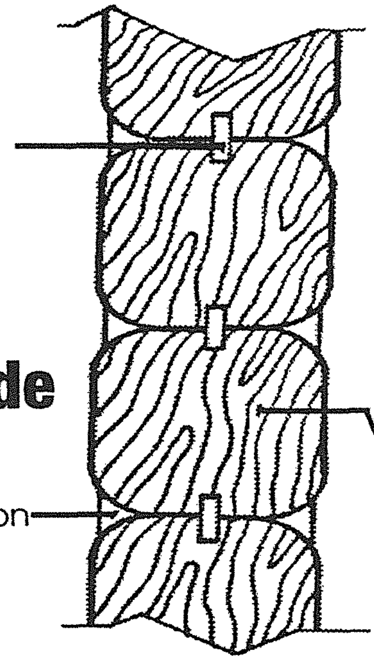
ASHRAE STEADY STATE U= VALUE $\frac{0.058 \text{ BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.067	.056	.046	.064	.051	.037	.062	.044	.026	.065	.052	.038
2	.062	.056	.051	.060	.052	.045	.058	.048	.037	.061	.053	.046
3	.061	.056	.052	.059	.053	.046	.057	.048	.038	.060	.054	.048
4	.060	.057	.054	.059	.053	.047	.056	.047	.037	.059	.054	.048
5	.060	.057	.054	.059	.052	.046	.056	.046	.036	.059	.054	.048
6	.061	.057	.054	.059	.052	.046	.056	.045	.034	.059	.053	.048
7	.061	.058	.054	.059	.052	.045	.056	.044	.032	.060	.053	.047
8	.062	.058	.054	.060	.051	.043	.056	.042	.028	.060	.053	.045
9	.064	.059	.053	.060	.050	.040	.056	.040	.023	.061	.052	.043
10	.066	.059	.053	.062	.049	.036	.057	.036	.015	.063	.051	.040
11	.068	.060	.052	.063	.048	.033	.057	.033	.009	.064	.051	.037

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

WALL TYPE 26



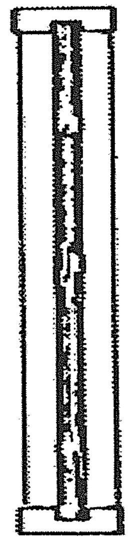
ASHRAE STEADY STATE U= VALUE $\frac{0.099 \text{ BTU}}{\text{hr SF °F}}$

EFFECTIVE "U" - VALUE (U_E): HEATING												
N.M. Climatic Region	Wall Orientation											
	North			East			South			West		
	*L	M	D	L	M	D	L	M	D	L	M	D
1	.089	.071	.052	.087	.066	.044	.085	.059	.035	.088	.067	.045
2	.091	.074	.058	.086	.063	.040	.080	.047	.015	.087	.065	.043
3	.091	.075	.060	.086	.062	.038	.078	.042	.008	.087	.064	.042
4	.092	.078	.063	.085	.060	.036	.074	.034	-005	.086	.063	.041
5	.093	.078	.064	.085	.059	.034	.073	.031	-010	.086	.062	.040
6	.093	.078	.064	.084	.057	.031	.071	.026	-019	.086	.061	.036
7	.093	.077	.062	.083	.053	.024	.069	.018	-032	.085	.058	.031
8	.094	.076	.057	.082	.047	.013	.065	.006	-053	.084	.052	.020
9	.095	.073	.051	.081	.038	-003	.061	-009	-079	.083	.045	.006
10	.096	.066	.037	.078	.023	-031	.055	-035	-126	.081	.031	-019
11	.097	.062	.028	.076	.013	-051	.050	-053	-157	.080	.022	-037

*Wall Colors: L = Light
M = Medium
D = Dark

NOTE: All entries in this table are preceded by "0." That is: .122 = 0.122; -122 = -0.122.

NOTE: These tables pertain to net glass area only and the heat transfer through the frame must be calculated separately.



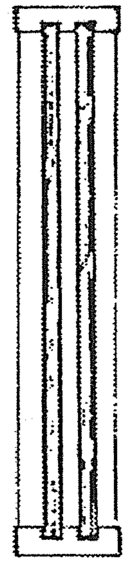
#1 - No Inside Attention.
#2 - Drape, Drawn at Night.
#3 - Night Insulation, R-5.

EFFECTIVE "U"-FACTORS FOR SINGLE GLAZING												
N.M. Climatic Region	Glass Orientation											
	North			East			South			West		
	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3
1	0.581	0.303	0.062	0.563	0.285	0.044	0.523	0.246	0.004	0.564	0.286	0.045
2	0.616	0.328	0.087	0.446	0.158	-0.083	0.144	-0.144	-0.385	0.472	0.184	-0.056
3	0.629	0.337	0.097	0.402	0.111	-0.130	0.005	-0.287	-0.527	0.439	0.147	-0.093
4	0.652	0.353	0.113	0.326	0.027	-0.213	-0.242	-0.540	-0.780	0.379	0.081	-0.159
5	0.655	0.354	0.114	0.301	0.000	-0.240	-0.314	-0.614	-0.854	0.359	0.058	-0.182
6	0.648	0.344	0.103	0.255	-0.049	-0.290	-0.420	-0.724	-0.965	0.320	0.015	-0.225
7	0.629	0.319	0.077	0.196	-0.114	-0.355	-0.537	-0.847	-1.089	0.267	-0.043	-0.284
8	0.587	0.268	0.025	0.103	-0.216	-0.459	-0.699	-1.018	-1.261	0.182	-0.136	-0.380
9	0.524	0.195	-0.051	-0.014	-0.343	-0.589	-0.881	-1.210	-1.456	0.075	-0.255	-0.501
10	0.403	0.055	-0.196	-0.212	-0.560	-0.812	-1.163	-1.511	-1.762	-0.112	-0.459	-0.711
11	0.317	-0.043	-0.298	-0.344	-0.703	-0.959	-1.338	-1.698	-1.953	-0.236	-0.596	-0.851

NOTE: These effective "U"-Factors assume that 100% of the energy entering through the glass is usable.

NOTE: Negative numbers indicate a heat gain instead of a heat loss.

NOTE: These tables pertain to net glass area only and the heat transfer through the frame must be calculated separately.



#1 - No Inside Attention.
#2 - Drape, Drawn at Night.
#3 - Night Insulation, R-5.

EFFECTIVE "U"-FACTORS FOR DOUBLE GLAZING

N.M. Climatic Region	Glass Orientation											
	North			East			South			West		
	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3
1	0.124	0.002	-0.136	0.111	-0.010	-0.148	0.081	-0.041	-0.179	0.112	-0.010	-0.148
2	0.152	0.026	-0.112	0.012	-0.114	-0.252	-0.244	-0.370	-0.508	0.035	-0.091	-0.229
3	0.162	0.035	-0.103	-0.025	-0.152	-0.289	-0.363	-0.490	-0.628	0.006	-0.121	-0.259
4	0.180	0.051	-0.087	-0.089	-0.219	-0.356	-0.575	-0.704	-0.842	-0.044	-0.174	-0.311
5	0.182	0.052	-0.086	-0.111	-0.241	-0.379	-0.637	-0.767	-0.905	-0.061	-0.192	-0.329
6	0.175	0.042	-0.095	-0.151	-0.283	-0.420	-0.728	-0.860	-0.998	-0.096	-0.228	-0.366
7	0.155	0.021	-0.118	-0.203	-0.338	-0.476	-0.830	-0.964	-1.103	-0.143	-0.277	-0.416
8	0.113	-0.024	-0.164	-0.287	-0.425	-0.564	-0.971	-1.109	-1.248	-0.220	-0.357	-0.497
9	0.052	-0.090	-0.231	-0.392	-0.534	-0.675	-1.130	-1.271	-1.413	-0.317	-0.459	-0.600
10	-0.065	-0.214	-0.358	-0.573	-0.723	-0.867	-1.377	-1.527	-1.671	-0.488	-0.637	-0.781
11	-0.148	-0.302	-0.448	-0.693	-0.848	-0.994	-1.531	-6.685	-1.832	-0.602	-0.756	-0.902

NOTE: These effective "U"-Factors assume that <u>100%</u> of the energy entering through the glass is usable.

NOTE: Negative numbers indicate a heat gain instead of a heat loss.

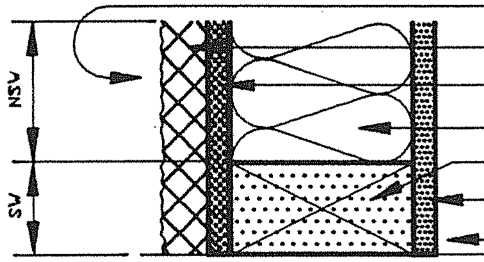
EFFECTIVE U-VALUES FOR ROOFS/CEILINGS

Description of Roofs

1. Pitch Roof, Med. Color, Asphalt Shingles, R-11 Ceiling Insulation
2. Pitch Roof, Dark Color, Asphalt Shingles, R-11 Ceiling Insulation
3. Pitch Roof, Med. Color, Asphalt Shingles, R-19 Ceiling Insulation
4. Pitch Roof, Med. Color, Asphalt Shingles, R-19 Ceiling Insulation Foil Backed
5. Pitch Roof, Dark Color, Asphalt Shingles, R-19 Ceiling Insulation
6. Pitch Roof, Dark Color, Asphalt Shingles, R-19 Ceiling Insulation Foil Backed
7. Flat, Med. Color, B.U. Roofing, R-19 Ceiling Insulation
8. Flat, Dark Color, B.U. Roofing, R-19 Ceiling Insulation
9. Pitch Roof, Galv. Metal, R-19 Ceiling Insulation
10. Pitch Roof, Galv. Metal, R-19 Ceiling Insulation, Foil Backed

		Effective U-Values									
		Roof Number									
Climatic Region	Degree Days	1	2	3	4	5	6	7	8	9	10
1	9316	0.074	0.062	0.046	0.036	0.040	0.037	0.046	0.039	0.028	0.028
2	7681	0.074	0.062	0.046	0.036	0.040	0.037	0.046	0.039	0.028	0.028
3	7082	0.074	0.062	0.046	0.036	0.040	0.037	0.046	0.039	0.028	0.028
4	6018	0.074	0.062	0.046	0.036	0.040	0.037	0.046	0.039	0.028	0.028
5	5720	0.073	0.062	0.046	0.036	0.040	0.036	0.046	0.039	0.028	0.028
6	5321	0.072	0.061	0.046	0.036	0.039	0.036	0.046	0.038	0.027	0.027
7	4919	0.071	0.059	0.046	0.035	0.038	0.035	0.045	0.037	0.025	0.025
8	4418	0.070	0.055	0.045	0.034	0.036	0.034	0.045	0.035	0.021	0.022
9	3911	0.069	0.051	0.044	0.032	0.033	0.032	0.044	0.032	0.016	0.019
10	3203	0.068	0.044	0.043	0.029	0.029	0.030	0.043	0.027	0.007	0.012
11	2803	0.067	0.038	0.043	0.027	0.025	0.027	0.042	0.024	0.001	0.007
Steady State		0.073	0.073	0.046	0.046	0.046	0.046	0.046	0.046	0.047	0.047

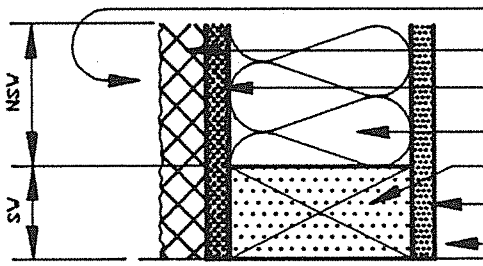
R-11 STUCCO WALL



NO STUD SECTION (NSW) (85%)	R-VALUES	STUD SECTION (SW) (15%)
0.17	OUTSIDE AIR FILM	0.17
0.20	1" STUCCO	0.20
1.38	1/2" ASPHALT SHEATHING & PAPER	1.38
11	INSULATION	-
-	2 X 4 16 O.C.	4.38
0.45	1/2" DRYWALL	0.45
0.68	INSIDE AIR FILM	0.68
13.88	TOTAL RESISTANCE	7.26

COMPOSITE R-11 STUCCO WALL RESISTANCE 12.21

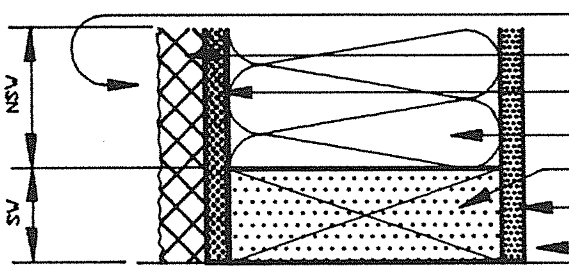
R-13 STUCCO WALL



NO STUD SECTION (NSW) (85%)	R-VALUES	STUD SECTION (SW) (15%)
0.17	OUTSIDE AIR FILM	0.17
0.20	1" STUCCO	0.20
1.38	1/2" ASPHALT SHEATHING & PAPER	1.38
13	INSULATION	-
-	2 X 4 16 O.C.	4.38
0.45	1/2" DRYWALL	0.45
0.68	INSIDE AIR FILM	0.68
15.88	TOTAL RESISTANCE	7.26

COMPOSITE R-13 STUCCO WALL RESISTANCE 13.48

R-19 STUCCO WALL

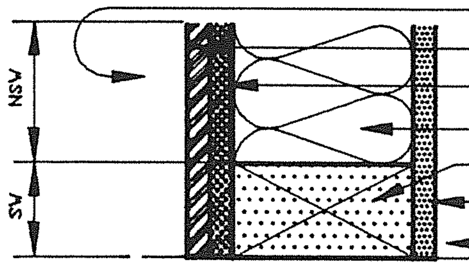


NO STUD SECTION (NSW) (90%)	R-VALUES	STUD SECTION (SW) (10%)
0.17	OUTSIDE AIR FILM	0.17
0.20	1" STUCCO	0.20
1.38	1/2" ASPHALT SHEATHING & PAPER	1.38
19	INSULATION	-
-	2 X 6 24 O.C.	6.88
0.45	1/2" DRYWALL	0.45
0.68	INSIDE AIR FILM	0.68
21.88	TOTAL RESISTANCE	9.76

COMPOSITE R-19 STUCCO WALL RESISTANCE 19.46

WALL SECTIONS

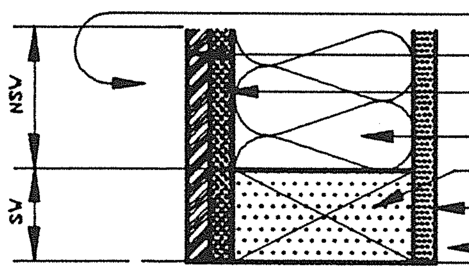
R-11 REGULAR WOOD FRAME WALL



NO STUD SECTION (NSW) (85%)	R-VALUES	STUD SECTION (SW) (15%)
0.17	OUTSIDE AIR FILM	0.17
0.81	1/2" LAPPED WOOD SIDING	0.81
1.32	1/2" SHEATHING	1.32
11	INSULATION	-
-	2 X 4 16 O.C.	4.38
0.45	1/2" DRYWALL	0.45
0.68	INSIDE AIR FILM	0.68
14.43	TOTAL RESISTANCE	7.81

COMPOSITE R-11 REGULAR WOOD WALL RESISTANCE 12.80

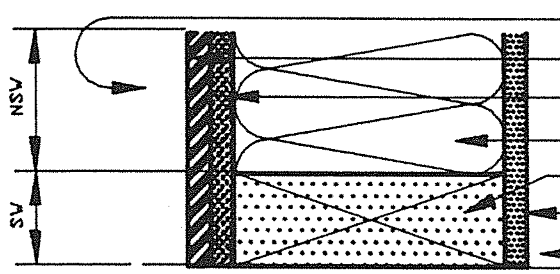
R-13 REGULAR WOOD FRAME WALL



NO STUD SECTION (NSW) (85%)	R-VALUES	STUD SECTION (SW) (15%)
0.17	OUTSIDE AIR FILM	0.17
0.81	1/2" LAPPED WOOD SIDING	0.81
1.32	1/2" SHEATHING	1.32
13	INSULATION	-
-	2 X 4 16 O.C.	4.38
0.45	1/2" DRYWALL	0.45
0.68	INSIDE AIR FILM	0.68
16.43	TOTAL RESISTANCE	7.81

COMPOSITE R-13 REGULAR WOOD WALL RESISTANCE 14.10

R-19 REGULAR WOOD FRAME WALL

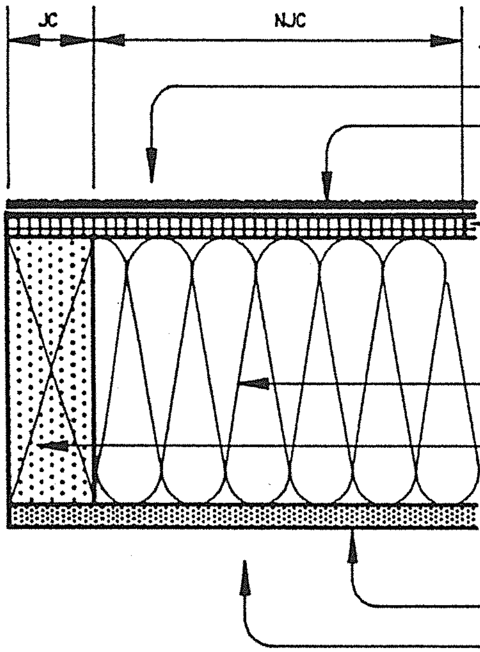


NO STUD SECTION (NSW) (90%)	R-VALUES	STUD SECTION (SW) (10%)
0.17	OUTSIDE AIR FILM	0.17
0.81	1/2" LAPPED WOOD SIDING	0.81
1.32	1/2" SHEATHING	1.32
19	INSULATION	-
-	2 X 6 24 O.C.	6.88
0.45	1/2" DRYWALL	0.45
0.68	INSIDE AIR FILM	0.68
22.43	TOTAL RESISTANCE	10.31

COMPOSITE R-19 REGULAR WOOD WALL RESISTANCE 20.07

WALL SECTIONS

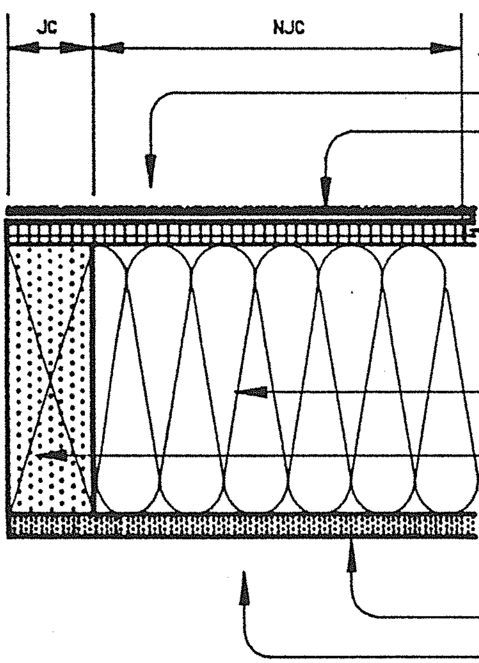
R-19 BUILT-UP ROOF (16" O.C.)



NO JOIST SECTION (NJC) (90%)	R-VALUES	JOIST SECTION (JC) (10%)
0.17	OUTSIDE AIR FILM	0.17
0.33	3/8" BUILT-UP ROOF	0.33
0.78	5/8" PLYWOOD	0.78
19	INSULATION	-
-	2 X 12 JOISTS 16 O.C.	14.38
0.45	1/2" DRYWALL	0.45
0.61	INSIDE AIR FILM	0.61
21.34	TOTAL RESISTANCE	16.72

COMPOSITE R-19 RESISTANCE 20.77

R-22 BUILT-UP ROOF (16" O.C.)

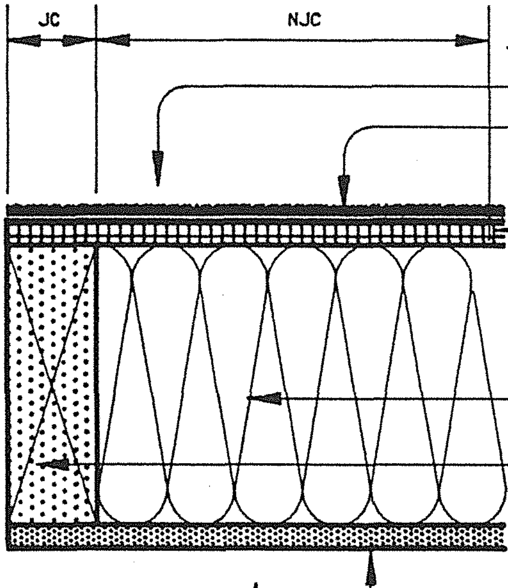


NO JOIST SECTION (NJC) (90%)	R-VALUES	JOIST SECTION (JC) (10%)
0.17	OUTSIDE AIR FILM	0.17
0.33	3/8" BUILT-UP ROOF	0.33
0.78	5/8" PLYWOOD	0.78
22	INSULATION	-
-	2 X 12 JOISTS 16 O.C.	14.38
0.45	1/2" DRYWALL	0.45
0.61	INSIDE AIR FILM	0.61
24.34	TOTAL RESISTANCE	16.72

COMPOSITE R-22 RESISTANCE 23.28

ROOF SECTIONS

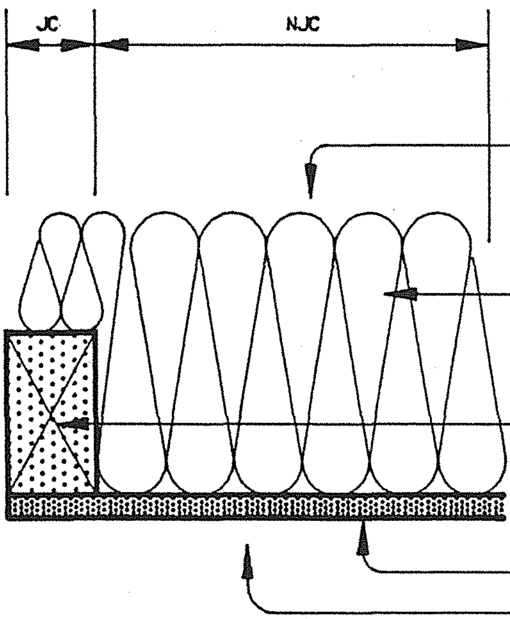
R-30 BUILT-UP ROOF (24" O.C.)



NO JOIST SECTION (NJC) (94%)	R-VALUES	JOIST SECTION (JC) (6%)
0.17	OUTSIDE AIR FILM	0.17
0.33	3/8" BUILT-UP ROOF	0.33
0.78	5/8" PLYWOOD	0.78
30	INSULATION	-
-	2 X 12 JOISTS 24 O.C.	14.38
0.45	1/2" DRYWALL	0.45
0.61	INSIDE AIR FILM	0.61
32.34	TOTAL RESISTANCE	16.72

COMPOSITE R-30 RESISTANCE 30.62

R-19 VENTED ATTICS/CEILINGS (24" O.C.)

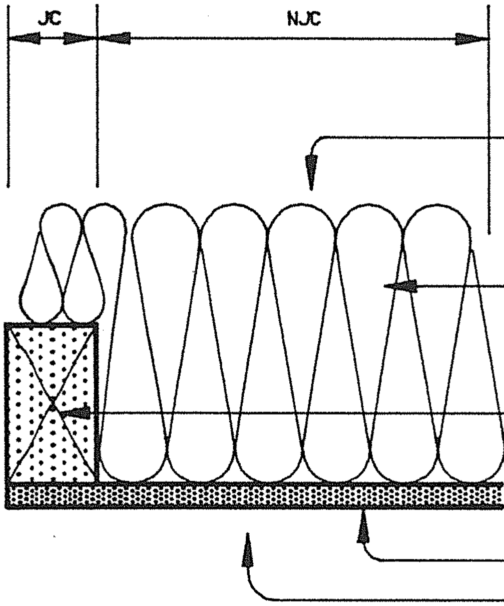


NO JOIST SECTION (NJC) (94%)	R-VALUES	JOIST SECTION (JC) (6%)
0.61	OUTSIDE AIR FILM	0.61
19	INSULATION	-
-	2 X 4 TRUSS 24 O.C.	4.38
0.45	1/2" DRYWALL	0.45
0.61	INSIDE AIR FILM	0.61
20.67	TOTAL RESISTANCE	6.05

COMPOSITE R-19 RESISTANCE 18.05

ROOF SECTIONS

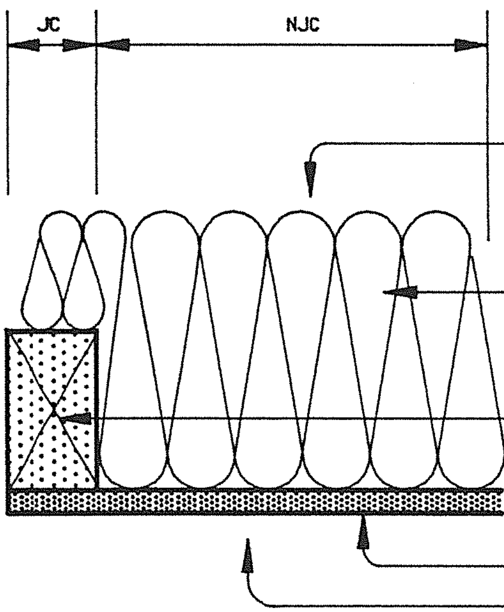
R-22 VENTED ATTICS/CEILINGS (24" O.C.)



NO JOIST SECTION (NJC) (94%)	R-VALUES	JOIST SECTION (JC) (6%)
0.61	OUTSIDE AIR FILM	0.61
22	INSULATION	-
-	2 X 4 TRUSS 24 O.C.	4.38
0.45	1/2" DRYWALL	0.45
0.61	INSIDE AIR FILM	0.61
23.67	TOTAL RESISTANCE	6.05

COMPOSITE R-22 RESISTANCE 20.15

R-30 VENTED ATTICS/CEILINGS (24" O.C.)



NO JOIST SECTION (NJC) (94%)	R-VALUES	JOIST SECTION (JC) (6%)
0.61	OUTSIDE AIR FILM	0.61
30	INSULATION	-
-	2 X 4 TRUSS 24 O.C.	4.38
0.45	1/2" DRYWALL	0.45
0.61	INSIDE AIR FILM	0.61
31.67	TOTAL RESISTANCE	6.05

COMPOSITE R-30 RESISTANCE 25.25

ROOF SECTIONS

HDD	R_o-VAL	R_o-VAL	R_o-VAL
3001-	ROOF: 26.32	UNHEATED SLAB: 4.00(24")	CRAWL WALL: 9.52
3500	FLOOR: 20.00	HEATED SLAB: 6.00(24")	BSMT WALL: 8.13

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	14.23	16.71	20.34	26.16							
1.5 (0.67)	9.32	9.90	10.57	11.36	12.30	13.44	14.84	16.62	18.95	22.13	26.73
2.0 (0.5)	7.95	8.22	8.52	8.85	9.22	9.63	10.09	10.61	11.19	11.87	12.65
2.5 (0.4)	7.30	7.46	7.63	7.82	8.02	8.23	8.46	8.71	8.99	9.28	9.61
3.0 (0.33)	6.93	7.03	7.14	7.25	7.38	7.50	7.64	7.79	7.94	8.11	8.28
3.5 (0.29)	6.68	6.75	6.82	6.90	6.98	7.06	7.15	7.24	7.33	7.43	7.54
4.0 (0.25)	6.51	6.56	6.60	6.65	6.71	6.76	6.81	6.87	6.93	7.00	7.06

HDD	R_o-VAL	R_o-VAL	R_o-VAL
3501-	ROOF: 28.09	UNHEATED SLAB: 4.00(24")	CRAWL WALL: 11.11
4000	FLOOR: 20.00	HEATED SLAB: 6.00(24")	BSMT WALL: 8.92

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	16.17	19.50	24.68								
1.5 (0.67)	10.11	10.81	11.63	12.61	13.80	15.27	17.15	19.61	23.00	27.95	
2.0 (0.5)	8.52	8.84	9.20	9.60	10.04	10.54	11.10	11.75	12.49	13.35	14.38
2.5 (0.4)	7.78	7.97	8.17	8.39	8.63	8.89	9.17	9.47	9.80	10.17	10.57
3.0 (0.33)	7.36	7.48	7.61	7.75	7.89	8.05	8.21	8.39	8.57	8.77	8.99
3.5 (0.29)	7.08	7.16	7.25	7.34	7.44	7.54	7.64	7.75	7.87	7.99	8.12
4.0 (0.25)	6.89	6.94	7.00	7.06	7.13	7.19	7.26	7.34	7.41	7.49	7.57

HDD	R_o-VAL	R_o-VAL	R_o-VAL
4001-	ROOF: 30.12	UNHEATED SLAB: 4.00(24")	CRAWL WALL: 13.13
4500	FLOOR: 20.00	HEATED SLAB: 6.00(24")	BSMT WALL: 10.00

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	18.73	23.39									
1.5 (0.67)	11.06	11.91	12.93	14.17	15.72	17.69	20.30	23.91			
2.0 (0.5)	9.18	9.57	10.00	10.48	11.02	11.64	12.35	13.17	14.13	15.27	16.65
2.5 (0.4)	8.33	8.55	8.80	9.06	9.34	9.65	9.99	10.37	10.78	11.24	11.76
3.0 (0.33)	7.85	7.99	8.14	8.31	8.48	8.67	8.87	9.08	9.31	9.56	9.83
3.5 (0.29)	7.53	7.63	7.74	7.84	7.96	8.08	8.21	8.34	8.49	8.64	8.80
4.0 (0.25)	7.31	7.38	7.45	7.53	7.61	7.69	7.77	7.86	7.96	8.06	8.16

HDD	R_0-VAL	R_0-VAL	R_0-VAL
4501-	ROOF: 32.47	UNHEATED SLAB: 4.33(24")	CRAWL WALL: 16.67
5000	FLOOR: 20.00	HEATED SLAB: 6.38(24")	BSMT WALL: 10.10

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	22.26										
1.5 (0.67)	12.20	13.26	14.56	16.18	18.26	21.02	24.88				
2.0 (0.5)	9.95	10.42	10.94	11.53	12.21	12.99	13.90	14.97	16.26	17.83	19.78
2.5 (0.4)	8.96	9.23	9.52	9.84	10.19	10.57	10.99	11.46	11.98	12.57	13.24
3.0 (0.33)	8.40	8.58	8.76	8.96	9.17	9.40	9.64	9.91	10.19	10.51	10.84
3.5 (0.29)	8.05	8.16	8.29	8.42	8.56	8.71	8.87	9.04	9.21	9.40	9.60
4.0 (0.25)	7.80	7.88	7.97	8.06	8.16	8.26	8.36	8.48	8.59	8.72	8.85

HDD	R_0-VAL	R_0-VAL	R_0-VAL
5001-	ROOF: 35.21	UNHEATED SLAB: 4.76(24")	CRAWL WALL: 16.67
5500	FLOOR: 20.00	HEATED SLAB: 6.76(24")	BSMT WALL: 10.31

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)	27.42										
1.5 (0.67)	13.60	14.96	16.66	18.85	21.78	25.89					
2.0 (0.5)	10.87	11.44	12.08	12.83	13.69	14.70	15.90	17.35	19.15	21.41	24.37
2.5 (0.4)	9.70	10.02	10.37	10.76	11.19	11.67	12.20	12.80	13.48	14.25	15.14
3.0 (0.33)	9.05	9.26	9.48	9.72	9.98	10.26	10.57	10.90	11.26	11.66	12.09
3.5 (0.29)	8.63	8.78	8.93	9.09	9.26	9.45	9.64	9.85	10.07	10.31	10.57
4.0 (0.25)	8.35	8.45	8.56	8.67	8.79	8.92	9.05	9.19	9.34	9.49	9.66

HDD	R_0-VAL	R_0-VAL	R_0-VAL
5501-	ROOF: 38.46	UNHEATED SLAB: 5.00(24")	CRAWL WALL: 16.67
6000	FLOOR: 20.00	HEATED SLAB: 7.14(24")	BSMT WALL: 10.42

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)											
1.5 (0.67)	15.37	17.15	19.46	22.57	26.97						
2.0 (0.5)	11.97	12.67	13.49	14.45	15.57	16.93	18.58	20.64	23.28	26.81	
2.5 (0.4)	10.56	10.96	11.40	11.88	12.42	13.03	13.72	14.51	15.41	16.46	17.69
3.0 (0.33)	9.79	10.05	10.33	10.62	10.95	11.30	11.69	12.11	12.57	13.09	13.66
3.5 (0.29)	9.31	9.49	9.68	9.88	10.09	10.32	10.57	10.83	11.11	11.42	11.75
4.0 (0.25)	8.98	9.11	9.24	9.38	9.53	9.69	9.86	10.03	10.22	10.42	10.64

HDD	R_0-VAL	R_0-VAL	R_0-VAL
6001-	ROOF: 38.46	UNHEATED SLAB: 5.33(48")	CRAWL WALL: 16.67
6500	FLOOR: 20.00	HEATED SLAB: 7.52(48")	BSMT WALL: 10.52

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)											
1.5 (0.67)	17.67	20.10	23.40								
2.0 (0.5)	13.31	14.22	15.28	16.54	18.06	19.95	22.34	25.45			
2.5 (0.4)	11.60	12.09	12.64	13.26	13.96	14.75	15.67	16.73	17.98	19.47	21.27
3.0 (0.33)	10.68	11.00	11.34	11.71	12.12	12.57	13.07	13.62	14.23	14.92	15.70
3.5 (0.29)	10.11	10.33	10.56	10.81	11.08	11.37	11.68	12.02	12.39	12.79	13.23
4.0 (0.25)	9.72	9.88	10.04	10.22	10.41	10.61	10.82	11.05	11.29	11.55	11.83

HDD	R_0-VAL	R_0-VAL	R_0-VAL
6501-	ROOF: 38.46	UNHEATED SLAB: 5.67(48")	CRAWL WALL: 16.67
7000	FLOOR: 20.00	HEATED SLAB: 7.90(48")	BSMT WALL: 10.63

OPAQUE EXTERIOR WALL ASSEMBLY R-VALUE

FENESTRATION ASSEMBLY R-VALUE (U-VAL)	PERCENT OPEN AREA OF WINDOWS & DOORS IN EXT. WALL 10	11	12	13	14	15	16	17	18	19	20
1.0 (1.0)											
1.5 (0.67)	20.77	24.27									
2.0 (0.5)	15.00	16.18	17.60	19.33	21.50	24.29					
2.5 (0.4)	12.86	13.48	14.19	15.00	15.93	17.00	18.26	19.76	21.58	23.82	26.67
3.0 (0.33)	11.74	12.14	12.57	13.05	13.58	14.17	14.82	15.56	16.40	17.36	18.46
3.5 (0.29)	11.05	11.33	11.62	11.94	12.29	12.66	13.07	13.51	14.00	14.54	15.14
4.0 (0.25)	10.59	10.79	11.00	11.23	11.47	11.72	12.00	12.30	12.62	12.96	13.33

The above table for 6501 - 7000 HDD applies to climates up to 9000 HDD with the following values for slab, and basement walls.

HDD	Unheated Slab (48")	Heated Slab (48")	Bsmt Walls
7001 - 7500	6.00	8.28	10.89
7501 - 8000	6.33	8.66	10.99
8001 - 8500	6.67	9.03	11.11
8501 - 9000	7.00	9.41	16.67

Instructions for Interpretive Requirements Tables:

To determine if a building design complies with the Component Performance Approach (MEC Ch.5), select the table that applies to your climate by comparing your heating degree days (HDD) with the value in the upper left hand corner of the table. Below is the table for HDD 2501 - 3000.

Example Table

HDD		R_o-VAL		R_o-VAL	R_o-VAL	
2501-	A	ROOF: 24.75	C	UNHEATED SLAB: 4.00	CRAWL WALL: 8.97	D
3000	B	FLOOR: 20.00		HEATED SLAB: 6.00(24")	BSMT WALL: 7.41	E

R-VALUE GLASS	PERCENT OPEN AREA 10	11	12	13	14	15	16	17	18	19	20	G
1.0	12.70	14.62	17.30	21.29	27.86							
1.5	8.64	9.12	9.68	10.33	11.09	11.99	13.08	14.43	16.12	18.32	21.31	H
2.0	7.45	7.68	7.94	8.22	8.53	8.87	9.24	9.67	10.14	10.68	11.29	
2.5	6.88	7.02	7.16	7.32	7.49	7.67	7.86	8.07	8.29	8.54	8.80	
3.0	6.54	6.63	6.72	6.82	6.92	7.03	7.15	7.27	7.40	7.53	7.68	
3.5	6.32	6.38	6.44	6.51	6.57	6.64	6.71	6.79	6.87	6.95	7.03	
4.0	6.17	6.21	6.25	6.29	6.33	6.37	6.42	6.47	6.51	6.57	6.62	

↑ F

In the MEC, requirements for each building component are expressed in overall thermal transmittance values, U_0-values. In the Interpretive Requirements Tables, each of these values has been converted to component assembly R_0-values. The required R-values for (A) roofs, (B) floors and (D) crawl space or (E) basement walls are listed at the top of each table. Explanations of how to meet these requirements and examples of how to meet exterior wall requirements follow. Note that in the following tables R-values different from those listed can be added to the base case for system R-value.

(A) Roof/Ceiling Assembly R-value:

In the above example, the required R-value (R_0) of the roof is 24.75 (Box A). This R_0-value is determined by combining the thermal resistance of each material that makes up the roof/ceiling assembly, i.e insulation, framing, gypsum board, air film, etc. The tables below provide precalculated overall thermal resistances of assemblies for a variety of installed insulation R-values for both cathedral ceilings and flat ceilings with an attic air space. For roof/ceiling assemblies that include skylights totalling 1% or less of the roof in area, no adjustment is required. For more than 1% skylight area, see the MEC. As shown below, an installed insulation value of R-26 or greater will comply with the example.

Flat Ceilings

R-value of Installed Insulation	System R_0-value: Trusses[1] 24" O.C.	Joists[2] 16" O.C.
19	20.1	20.0
22	23.0	22.2
26	27.1	26.4
30	31.1	30.5
38	39.1	38.5
49	50.1	49.5

1. Insulation must cover the bottom cord.
2. Insulation level deeper than joist dimension shall cover joist.

Cathedral Ceilings Assemblies

R-value of Installed Insulation	System R_0-value[1]: 2x8	2x10	2x12
19	20.0	20.0	20.0
22	22.3	22.9	22.9
26	—[2]	26.2	26.2
30	—[2]	29.9[3]	30.0
38	—[2]	—[2]	37.5

1 System R-values can be increased with insulative sheathing between the gypsum board and framing.
2 Insufficient room.
3 High Performance cathedral batt (approx 8½")

(B) Floor Assembly R-value:

(Example: R_0 = 20.0) This R_0-value (Box B) applies to floors over unheated spaces, such as, crawl spaces, basements and garages. The R_0-values in the table below are the overall floor thermal resistance values determined by combining floor joists (wood 16"oc), sub-flooring, insulation and air films. Note: floors over outside air are to be insulated to the same requirements as the roof assembly (Box A). As shown below, an R-19 insulation or greater will meet the MEC in this example.

Floor Assemblies

R-value of Installed Insulation	System R_0-value
11	12.5
13	14.1
19	20.1
30	29.4
38	36.6

(C) Slab Edge Insulation R-value:

(R=4.0/6.0) This R-value is for the perimeter insulation only and applies to unheated and heated slab floors (Box C). Note that the required length of insulation, 24" or 48", is installed against the slab edge, starting at the top and extending downward vertically, and/or horizontally under the slab as in the diagram in this chapter.

(D) Crawl Wall Assembly R-value:

(Example: R_0 = 8.97) This R_0-value is the resultant crawl wall thermal resistance needed to comply with this component requirement (Box D). The R_0-value of the assembly is determined by combining the R-values of the insulation, foundation wall material and air films. The R_0-values of typical crawl wall constructions are provided below.

Crawl Space Wall Assemblies

R-value of Installed Insulation[1]	System R_0-value[2]
0	1.7
3	4.7
4.5	6.2
6	7.7
10	11.7
11	12.7
13	14.7
19	20.7
30	31.7

1. Insulation in this table is interior draped batt or blanket materials.

2. If exterior insulative sheathing materials are chosen, the assembly R_0-value can be approximated by adding the rated R-value plus the thermal resistance of the block/concrete structure and air film, equivalent to a value of R-1.7

(E) Basement Wall Assembly R-value:

(Example: $R_0 = 7.41$) This applies to the basement wall area when the total wall is 50 percent or more below grade. This R_0-value (Box E) is the resultant opaque basement wall thermal resistance needed to comply. The R_0-value is determined by combining the thermal resistances of materials through the opaque portion of the basement walls (structural material, insulation, framing, finish material and inside air film). Non-opaque areas (windows and doors) of basements must be included in the gross exterior wall area.

Basement walls must be insulated when the space is conditioned. For basement walls with below grade area less than 50 percent of the total basement wall area, the entire wall, including the below-grade portion, is included in the gross wall area, see Exterior Wall Assembly below.

The R-values of typical basement wall construction are provided below, and include 8" hollow masonry units, framing, finish materials and cavity insulation. These values, being at the lower end of the range of available masonry products, can also be used for poured concrete R_0-values.

Basement Wall Assemblies

R-value of Installed Insulation[1]	Full Wall System R_0-Value
0	1.7
3	4.7
4.3	6.0
6	7.7
10	11.7
11	12.7
13	14.7
15	16.7
19	20.7
21	22.7

1. Insulation in this table is interior to the foundation wall in the stud cavity as indicated. Studs are 24" O.C

2. Exterior insulative sheathing materials result in an assembly R_0-value determined by the rated sheathing R-value plus the thermal resistance of the block/concrete structure and air film, equivalent to a value of R-1.7

(F, G & H) Exterior Wall Assembly R-value:

The remainder of the table consists of an array of possible opaque wall and glazing combinations. The wall insulation values (Box H), glazing performance (Box F) and percent window/door open area (Box G) are interdependent.

The gross area of walls consists of all opaque wall areas, including between floor spandrels, peripheral edges of floors, window areas including sash, and door areas, where such surfaces are exposed to outdoor air and enclose a heated or mechanically cooled space including interstitial areas between two such spaces. For basement walls with an average below-grade area less than 50 percent of the total wall area, including openings, the entire wall, including the below-grade portion, is included as part of the gross wall area. Nonopaque areas (windows, doors, etc.) of all basement walls are included in the gross wall area.

Glazing Performance and Percent Open Area: The percent open area, which indicates window/door openings as a percentage of the total wall area, is determined by dividing the total window plus door area by the gross exterior wall area. By selecting the performance of the window used and the open area, the required R-value of the opaque wall assembly can be determined. (See definition of Gross Wall Area in Chapter 2 of the MEC.) Note that the windows and doors of basements are to be included in the glazing area for determining the percent of gross wall area.

Selected Opaque Wall Constructions:
The following system R-values were determined in the manner shown in Chapter 3 of the Guide. All systems include 1/2 inch drywall (R-0.45), 16"oc framing and aluminum siding (R-0.61), unless otherwise indicated. The sheathing R-values used are as follows: non-insul (plywood) R-0.62; 1/2" foam = R-3.0; and 5/8" foam = R-3.13.

Wood Frame Wall Assemblies

R-value of Cavity Insulation		Sheathing[1]	Stud	System R_0-value[2]
11	+	non-insul	2x4	11.83
13	+	non-insul	2x4	13.08
13	+	1/2" foam	2x4	15.72
15	+	non-insul.	2x4	14.25
15	+	1/2" foam	2x4	17.00
15	+	5/8" foam	2x4	17.14
19	+	non-insul	2x6	17.33
19	+	1/2" foam	2x6	19.96
21	+	non-insul.	2x6	19.21
21	+	1/2" foam	2x6	21.96
21	+	5/8" foam	2x6	22.11
21	+	non-insul.	2x6 (24"oc)	20.07

1. The R_0-value of a wood frame wall assembly with sheathing other than that listed can be determined by adding the difference between the R-value of the sheathing in question and the non-insulative value of R-0.62, to the non-insulated system R-value.

2. System values are calculated based on 16"oc framing unless otherwise indicated.

Window Glazing Performance: The glazing table below is provided to give general information on available glazing types and ranges of performance. Actual window manufacturer's performance values should be used for determining and demonstrating compliance.

Example: Assume a 27 ft. X 58 ft. split level home with one 6 X 7.5 ft. aluminum double-pane sliding glass door, two exterior wood doors, and 311 sq. ft. double-pane wood frame windows (R-2.0). The resultant percent open area of wall is 13.7 of the gross exterior wall.

In the 2501 - 3000 HDD zone Example Table above, the corresponding opaque wall R-value needed to comply with this window combination is R-value = 8.53 (in the 14% column). This is easily met with any of the opaque wall constructions in the Table. In fact, moving up the column to the next window performance R-value 11.09, this same configuration would comply using a standard double-pane aluminum frame window with thermal break.

Performance of Typical Glazing Products

Glazing Type/Description	Typical R-values[1]
Sgl-pane, aluminum	0.76
Sgl-pane, aluminum w/ thermal break	0.92
Sgl-pane, wood or vinyl frame	1.11
Dbl-pane, aluminum	1.09 - 1.15
Dbl-pane, aluminum w/ thermal break	1.43 - 1.56
Dbl-pane, wood or vinyl frame	1.85 - 2.04
Dbl-pane, wood or vinyl frame w/ low-e	2.17 - 3.12
Dbl-pane, wood/vinyl, low-e, argon gas	2.56 - 4.16

1. The R-values provided are for informational purposes only. For actual performance consult the product manufacturer or representative.

Door Performance: The door performance table below indicates typical performance values of doors available on the market. These values are applicable primarily to Chapter 2 calculations of this document.

Exterior Door Thermal Performance

Description	R-Value
Wood 1-3/8 inches	
7/16 in panel	1.75
Flush, hollow	2.13
Flush, solid	2.56
Wood 1-3/4 inches	
7/16" panel	1.75
Flush hollow	2.17
1-1/8" panel	2.56
Flush, solid	3.03
Wood 2-1/4 inches	
Flush solid	3.70
Metal 1-3/4 inches	
Mineral fiber core w/o t. brk	1.67 - 2.63
Foam core w/o thermal brk	
Foam core w/ thermal brk	5.0 - 5.26
Added R-Value for Storm Door	
Wood	1.0 - 1.3
Metal	0.95 - 1.05

Calculating R-Values of Non-Listed Constructions

If the particular building section (roof/ceiling, wall or floor) construction is not found on the Application Worksheet, the thermal resistance of that assembly can be calculated from the R-values of its components. The following example calculates the system R-value of an opaque wall section. The R-values of each of the constituent parts of the wall are located in the reference RS-1, Chapter 7 of the MEC.

For the frame wall, the opaque portion has two heat flow paths: through the framing and through the insulated cavity. The following demonstrates how the R-values are calculated through these paths:

Component	R_i (insulation)	R_f (framing)
Inside air film	0.68	0.68
1/2" drywall	0.45	0.45
Insulation (R-15 batt)	15.00	--
Framing (2x4, 16"oc)	--	4.38
Sheathing (1/2 plywood)	0.62	0.62
Siding	0.61	0.61
Outside air film	0.17	0.17
	R_i = 17.53	R_f = 6.91

After adding the R-values for each heat flow path, to get R_i = 17.53 and R_f = 6.91, the values are weighted according to their respective percentages of opaque wall area. Typical walls with 16"oc, 2x4 framing have about 15 percent framing when top and bottom plates, window and door headers, etc. are included. That leaves 85 percent of the opaque wall as cavity insulation.

The opaque wall R-value is calculated using the following equation:

$$R_0 = \frac{1}{a_1/R_1 + a_2/R_2 + \ . \ . \ . \ a_n/R_n}$$

Where: R_0 = the overall R-value (The opaque wall R_w-value in this example.)
a_1 = the decimal percent area of heat flow path #1 (85% = 0.85 for the insulation path in this example.)
R_1 = the total R-value of heat flow path #1 (17.53 in this example).
a_2, R_2 and succeeding a's and R's are for additional heat flow paths.

For this example with two heat flow paths, the equation becomes:

$$R_w = \frac{1}{(0.85/17.53) + (0.15/6.91)}$$

$$R_w = 14.24$$

This works out to R_w = 14.24, as listed in the wall table (G) for a typical wall with R-15 high performance batt insulation and non-insulative sheathing. In the example, a wall built to this would meet the code with an R_g = 1.5 (double-pane aluminum frame with thermal break) window up to a combined window/door opening of 16 percent. This is determined by selecting that value in the section (H) table of the Instructions for Interpretive Requirements which is less than and closest to 14.24, i.e. 13.08.

The exterior wall portion is used to determine the total R-value of opaque wall (R_w), in combination with the glazing performance (R_g) and door performance (R_d) and attributable percentage area, necessary to satisfy the MEC wall U_o criterion, where:

$$\frac{1}{U_0} = R_0 = A_0 \, x \left(\frac{1}{(A_w/R_w) + (A_g/R_g) + (A_d/R_d)} \right)$$

and where:

A_w = opaque wall area R_w = opaque wall R-value
A_g = glazing area R_g = glazing R-value
A_d = door area R_d = door R-value
A_o = gross wall area R_o = overall R-value

Note: A_o, A_w, A_g and A_d are actual areas; a_1, a_2, etc. on the previous page are decimal areas.

CHAPTER 2 MEETING THE MEC USING TRADE-OFFS

The previous chapter focused on MEC compliance using construction methods that meet individual component requirements of the code. The Applications Worksheet was used to verify compliance. This chapter will address MEC compliance where one or more component assemblies are below code requirements and trade-offs between designs and requirements are used.

This procedure, described in Chapter 5 of the MEC, allows for MEC compliance where the U_0 value of an assembly (such as wall, roof or floor) is increased (e.g., if it uses less insulation), while the U_0 value of other assemblies are decreased resulting in an equivalent thermal transmittance over all the exterior areas. The house complies with the MEC as long as the overall heat loss (or gain) of the entire envelope is not greater than it would be if each envelope component met MEC requirements.

Compliance Using the Trade-off Option

If each of the building components meets its applicable R-value requirement, the design complies with the thermal envelope requirements of the MEC. When one or more components do not comply, one option is to modify the design to achieve compliance. Another option is to trade-off the energy saved by one building component that exceeds the code requirement for the excess energy used by a component that does not meet the code requirement.

Such "trade-offs" are allowed under Chapter 5 of the MEC, between exterior walls, roof/ceilings, floors and other building elements. This chapter in this Guide addresses trade-offs in more detail. In this process the specific design geometry, such as component dimensions and area are fixed and the additional thermal performance in one component is "traded" to compensate for the shortfall in thermal performance in another, for an equivalent heat loss of the structure. The equation below can be used for trade-offs.

$$(1/R_{req'd1} - 1/R_{design1}) \times A_{component1} \geq (1/R_{design2} - 1/R_{req'd2}) \times A_{component2}$$

Energy saved by components that exceed requirements	equals or is greater than	Excess energy used by components that do not meet requirements

Where: R_{design} = Total R-value of the design

$R_{req'd}$ = Total R-value required from the Application Worksheet

$A_{component}$ = The area of the component

Additional components can be added to either side to compensate for differences between the design and the requirements.

For example, suppose the Applications Worksheet requires a total R-value in a cathedral ceiling of 38.46 and a total R-value in the opaque wall of 13.05. The design specifies a total R-value of 29.5 in the cathedral ceiling (worse) and a total R-value in the opaque wall of 15.72 (better). Does the "trade-off" work if the opaque wall area is 1,500 sq. ft. and the cathedral ceiling area is 1,000 sq. ft. ?

In this example, the wall R-value of 15.72 exceeds the requirement of R-13.05. The energy saved by the wall must equal or exceed the extra energy use caused by the design ceiling R-value of 29.5 vs the requirement of R-38.46.

Inserting the appropriate R-values into the previous equation results in:

$$(1/13.05 - 1/15.72) \times 1500 \geq ? \ (1/29.5 - 1/38.46) \times 1000$$

$$19.52 \geq 7.9$$

Since 19.52 is greater than 7.9, the energy saved by the wall (exceeding the requirement) compensates for the additional energy lost by the cathedral ceiling. If the left side of the equation were not larger than the right side, this trade-off would not satisfy the code.

Skylight Trade-offs

Skylights are generally large holes in the thermal envelope that add considerably to the summer heat gain of the building. Skylights have advantages of adding passive lighting and aesthetics to the indoor environment and are often requested features in new homes.

Skylight trade-offs are accomplished using the equation below by using the skylight assembly R-value and area as one heat flow path and the ceiling assembly R-value and area as another. The overall thermal resistance of the assembly is then calculated:

We will use the ceiling in the previous example where the 1000 sq. ft. cathedral ceiling has an R-30 cathedral batt in a roof/ceiling constructed with 2x10's 16"oc, and skylight thermal performance of R-1.82 and 15 sq. ft. area.

$$R_0 = \frac{A_0}{(A_S/R_S) + (A_T/R_T)}$$

$$= \frac{1000}{(15/1.82)+(985/29.7)}$$

$$= 24.15$$

The R_0-value for the cathedral ceiling with 1.5 percent skylight area complies with R_0-values for roofs up to 2500 HDD. To use this particular design in higher HDD climates, higher performance skylights, decreased skylight area, increased insulation R-values or trade-offs with other components have to be made.

Note: Curbs and/or skylight shafts should be insulated to the same level as the surrounding ceiling.

To assist in the trade-off compliance procedure this guide has included a second compliance tool, the Trade-Off Worksheet.

Using the Trade-Off Worksheet

The Trade-Off Worksheet compares "**Your House**" with a virtually identical house that complies with the MEC through the component performance approach described in the previous chapter. If **Your House** uses equal or less energy than the "**Code House**", as calculated on the Trade-Off Worksheet, it complies with the MEC.

Start first with **Your House** on the left side of the form. Calculate roof/ceiling sub-component areas: Ceiling/attic, cathedral ceiling and skylight; add these to lines 1, 2, and 3. Their total equals the total roof area and should be shown on line A, on the **Code House** side. Add the R-values of the roof sub-components to lines 1, 2 and 3 from the previous chapter, or calculate them.

Next, calculate the areas of the windows, doors, sliders and opaque wall and insert them in lines 5 through 10. Extra lines have been allocated to windows in case the design has more than one window or door type (include basement doors or windows here). If you add up all these areas, it will equal the total exterior wall area of **Your House**; include this in line C of the **Code House** side, on the right side of the form. Now add in the R-values of your wall sub-components to lines 5 through 10. These are each drawn from charts shown under Instructions for Interpretive Requirements Tables, in the previous chapter. Or, they can be calculated in accordance with equations listed in the previous chapter and in MEC Chapter 5.

Then, if there is a crawl space or basement which is not heated or cooled, the floor above it will be insulated; calculate its area and include this floor area in both lines 12 (**Your House**) and E (**Code House**). Add to line 12 the R-value from the previous chapter, or calculate it. If **Your House** floor sits on a heated or cooled basement or crawl space, you can ignore line 12.

If **Your House** is slab-on-grade (not slab floors of houses with basements), the slab (perimeter) length is added to line 14. Add the slab-edge insulation R-value to be used, together with depth below the top of the slab to which the insulation will extend, to line 14 as well as to line G on the **Code House** side. The slab-edge configuration was explained in Chapter 1, above. For designs where slab edge insulation is omitted, enter an installed insulation R-value of 1.0 to avoid dividing by zero. An uninsulated slab R-value = 1.0 takes into account the combined thermal resistance of the adjacent soil for that portion of the slab below grade and an air film of the exposed portion. Omitting insulation from any component is difficult to compensate for by increasing the thermal resistance in other components. This is due to the first increment of insulation saving considerably more energy than the last increment.

If **Your House** basement or crawl space is conditioned and the floor above uninsulated, calculate the opaque wall area and add it to line 16. Select basement or crawl space wall R-values and include them in lines 16 or 18. Add total wall area to line I or K.

Perform calculations on **Your House**, dividing areas by R-values for each sub-component, to derive roof, wall and floor subtotals at lines 4, 11, 13, 15, 17 and/or 19, where appropriate. Then add subtotals and enter on line 20.

1989 and 1992 CABO Model Energy Code for One- and Two- Family Dwellings
Trade-Off Worksheet

Compliance by Whole House Performance Approach
The completion of this worksheet is intended to satisfy the building thermal envelope requirements of the MEC for the majority of building designs. Limitations of the procedures outlined here may not apply to unique constructions or extraordinary designs. For additional guidance consult the information in the MEC.

This form is to be used only for MEC compliance using the component performance approach as spelled out in MEC Chapter 5. Other documents are to be submitted if –
- Thermal Envelope components not covered by the Compliance Guide are used
- Compliance by Systems Analysis (MEC Chapter 4) is required.

Builder Name: ______________________ Date: __________
Address: ______________________
Submitted By: ______________________ Phone No: __________
Building Address: ______________________
Legal Description: Lot __________ Section: __________ County: __________
General Building Description: ______________________ **Your HDD:** __________

YOUR HOUSE	**CODE HOUSE**
ROOF/CEILING	**ROOF**
1 Clg/Attic area ____/R ____ = [______]	
2. Cath clg area ____/R ____ = [______]	
3. Skylights area ____/R ____ = [______]	
Total area ____	
Subtotal Roof . . . . 4.[______]	A. Area ______ x U.______ = ... [______]B.
WALL	**WALL**
5. Opaque area ____/R ____ = [______]	
6. Door area ____/R ____ = [______]	
7. Slider area ____/R ____ = [______]	
8. Window area ____/R ____ = [______]	
9. Window area ____/R ____ = [______]	
10. Other area ____/R ____ = [______]	
Total area ____	
Subtotal Wall . . . . 11.[______]	C. Area ______ x U.______ = ... [______]D.
FLOOR	**FLOOR**
12. Floor area ____/R ____ = 13.[______]	E. Area ______ x U.______ = ... [______]F.
and/or	and/or
14. Slab perim. (ft) ____ x depth (ft) ____ /slab edge insul'n R ____ = ... 15.[______]	G. Slab Perim. ____ x depth ____/R ____ = [______]H.
BASEMENT WALL	**BASEMENT WALL**
16. Opaque area ____/R ____ = 17.[______]	I. Area ______ x U______ = ... [______]J.
CRAWL SPACE WALL	**CRAWL SPACE WALL**
18. Area ____/R ____ = 19.[______]	K. Area ______ x U ______ = ... [______]L.
20. TOTAL OF 4, 11, 13, 15, 17, 19. [______]	**TOTAL of B,D,F,H,J,L . . . . . [______]M.**

Line 20 (Your House Total) must be less than or equal to line M (Code House Total).

COMPLIANCE CERTIFICATION
This home meets the requirements of the CABO Model Energy Code-1989/92

______________________ ______________________ __________
Builder/Designer Company Name Date

______________________ ______________________ __________
Building Official Jurisdiction Date

To complete the **Code House** side, add the HDD of your house location at the top, then include the U_0 levels for each envelope component. For ease of selection these have been charted in Table 3, Calculated Values for Envelope Components. Note that the slab-edge requirements in Table 3 are in R-values and belong in Line G, together with the depth of the insulation. In climates above 6,000 degree days add "2" after "depth" on the same line ("1" if below 6,000 HDD), denoting the required slab-edge insulating depth in feet. Calculate the subtotals and add the total to line M.

If **Your House** total (line 20) is less than or equal to **Code House** (line M) your house complies the with MEC and the completed Worksheet can be submitted to the building official for approval.

If **Your House** does not comply, you should modify the selection of any one or more sub-components to reduce the overall total until it is less than or equal to the **Code House** total on line M. You will notice that increasing the R-value of any element, such as wall insulation or window glazing, has the effect of reducing your total.

Alternatively, you can reduce your window area, with its relatively low R-value, and increase your wall area, with its high R-value, to reduce your total. Or, you can increase the R-value of roof construction and trade this off by installing lower R-value (and possibly less expensive) windows. You can trade off any components in this way and realize the bottom line benefits.

The Trade-Off Worksheet also allows you to compare the wall insulating performance in **Your House** with the wall in the **Code House** (line 11 vs. line D). Similar comparisons can be made between roof, floor and basement or crawl space totals. In this way you can see the weak or strong components of your thermal envelope in comparisons with MEC complying components and adjust them accordingly.

Calculating U_0-Values for Envelope Components

The **Code House** half of the Trade-Off Worksheet requires insertion of U_0-values for each envelope component (R_0-values for slab-edge insulation). To facilitate U_0 selection, Table 3 has been prepared as a one-stop reference sheet. Table 3 lists allowable U_0-values for roof, wall, floor, crawl space wall and basement wall; as well as allowable R-values and depths for slab-edge insulation.

The allowable values are charted by HDD's in 100 HDD increments. The HDD of your house location (rounded up to the next highest number) is included at the top of the Trade-Off Worksheet and is the basis for U_0-value and R-value insertions in all lines of its **Code House** section.

Table 3 consists of easy-to-use charts of requirements for envelope components. Table 2 lists the specific requirements and calculation procedures for deriving precise U_0-values and R-values as a function of HDD. Table 2 may be used to complete the **Code House** section if greater precision is required.

Of course, no construction assembly is prevented from being analyzed on the Trade-Off Worksheet, even it is not represented in these tables or on charts in Chapter 1, providing proper calculation procedures are used in deriving component performance values.

Additional Worksheets

Attached to this Guide are loose sheets of reproducible worksheets. These may be used to make multiple copies for submissions to building officials. It is intended that worksheets showing compliance, together with appropriate house plans, are suitable for submission to building departments and for their approval for a building permit. However, the form and content of applications should be verified with the building official.

Table 2. Equations and Specific Requirements

This table lists envelope U_0 value and R-value requirements for ranges of HDDs, including equations for derivation of requirements where appropriate.

Component	Heating Degree Day Range	Requirement/ Equation
Roof/Ceiling Max. UO-value	0 - 1000 1000 - 6000 6000 - 16000 >16500	0.05 $-4.8 \times 10^{-6} \times HDD + .0548$ 0.026 0.025
Walls Max. UO-value	0 - 2500 2500 - 7000 7000 - 13000 >14000	$-4.0 \times 10^{-6} \times HDD + .28$ $-1.555 \times 10^{-6} \times HDD + .2188$ 0.11 0.10
Floors Over Unheated Spaces Max. UO-value	0 - 1000 1001 - 2500 2501 - 15500 >16500	0.08 0.07 0.05 0.04
Unheated Slab Min. R-value	0 - 2499 2500 - 4500 4501 - 19500 >19500	none required R4 $6.66 \times 10^{-4} \times HDD + 1.0$ R14
Installed Insulation from Top of Slab	2500 - 5999 ≥6000	24 inches 48 inches
Heated Slab Min. R-value	0 - 499 500 - 4500 4501 - 19000 >19000	none required R6 $7.5862 \times 10^{-4} \times HDD + 2.5862$ R17
Installed Insulation from Top of Slab	500 - 5999 ≥6000	24 inches 48 inches
Crawl Space Walls Max. U-value	0 - 499 500 - 2000 2001 - 5000 ≥5001	none required 0.15 $-3.0 \times 10^{-6} \times HDD + 0.21$ 0.06
Basement Walls Max. U-value	0 - 1499 1500 - 4500 4501 - 8500 8501 - 9000 ≥9000	none required $-2.3333 \times 10^{-6} \times HDD + 0.205$ $-2.5 \times 10^{-6} \times HDD + 0.11125$ $-6.0 \times 10^{-6} \times HDD + 0.6$ 0.06

Table 3. Calculated Values for Envelope Components

For convenience the equations in Table 2 have been calculated for HDDs from 100 to 10,000 (100 HDD increments. Rounding up to the nearest HDD listing will permit reasonable accuracy f most instances.

HEATING DEGREE DAY (HDD)	ROOF/ CEILING Max. U0-value	WALL Max. U0-value	FLOOR Max. U0-value	UNHEATED SLAB Min. R-value	FT	HEATED SLAB Min. R-value	FT	CRAWL SPACE WALL Min. U-value	BASEMENT WALL Min. U-value	HEATING DEGREE DAY (HDD)
100	0.0500	0.276	0.08							100
200	0.0500	0.272	0.08							200
300	0.0500	0.268	0.08							300
400	0.0500	0.264	0.08							400
500	0.0500	0.260	0.08			6.00	2	0.150		500
600	0.0500	0.256	0.08			6.00	2	0.150		600
700	0.0500	0.252	0.08			6.00	2	0.150		700
800	0.0500	0.248	0.08			6.00	2	0.150		800
900	0.0500	0.244	0.08			6.00	2	0.150		900
1000	0.0500	0.240	0.08			6.00	2	0.150		1000
1100	0.0495	0.236	0.07			6.00	2	0.150		1100
1200	0.0490	0.232	0.07			6.00	2	0.150		1200
1300	0.0486	0.228	0.07			6.00	2	0.150		1300
1400	0.0481	0.224	0.07			6.00	2	0.150		1400
1500	0.0476	0.220	0.07			6.00	2	0.150	0.170	1500
1600	0.0471	0.216	0.07			6.00	2	0.150	0.168	1600
1700	0.0466	0.212	0.07			6.00	2	0.150	0.165	1700
1800	0.0462	0.208	0.07			6.00	2	0.150	0.163	1800
1900	0.0457	0.204	0.07			6.00	2	0.150	0.161	1900
2000	0.0452	0.200	0.07			6.00	2	0.150	0.158	2000
2100	0.0447	0.196	0.07			6.00	2	0.147	0.156	2100
2200	0.0442	0.192	0.07			6.00	2	0.144	0.154	2200
2300	0.0438	0.188	0.07			6.00	2	0.141	0.151	2300
2400	0.0433	0.184	0.07			6.00	2	0.138	0.149	2400
2500	0.0428	0.180	0.07	4.00	2	6.00	2	0.135	0.147	2500
2600	0.0423	0.178	0.05	4.00	2	6.00	2	0.132	0.144	2600
2700	0.0418	0.177	0.05	4.00	2	6.00	2	0.129	0.142	2700
2800	0.0414	0.175	0.05	4.00	2	6.00	2	0.126	0.140	2800
2900	0.0409	0.174	0.05	4.00	2	6.00	2	0.123	0.137	2900
3000	0.0404	0.172	0.05	4.00	2	6.00	2	0.120	0.135	3000
3100	0.0399	0.171	0.05	4.00	2	6.00	2	0.117	0.133	3100
3200	0.0394	0.169	0.05	4.00	2	6.00	2	0.114	0.130	3200
3300	0.0390	0.167	0.05	4.00	2	6.00	2	0.111	0.128	3300
3400	0.0385	0.166	0.05	4.00	2	6.00	2	0.108	0.126	3400
3500	0.0380	0.164	0.05	4.00	2	6.00	2	0.105	0.123	3500
3600	0.0375	0.163	0.05	4.00	2	6.00	2	0.102	0.121	3600
3700	0.0370	0.161	0.05	4.00	2	6.00	2	0.099	0.119	3700
3800	0.0366	0.160	0.05	4.00	2	6.00	2	0.096	0.116	3800
3900	0.0361	0.158	0.05	4.00	2	6.00	2	0.093	0.114	3900
4000	0.0356	0.157	0.05	4.00	2	6.00	2	0.090	0.112	4000
4100	0.0351	0.155	0.05	4.00	2	6.00	2	0.087	0.109	4100
4200	0.0346	0.153	0.05	4.00	2	6.00	2	0.084	0.107	4200
4300	0.0342	0.152	0.05	4.00	2	6.00	2	0.081	0.105	4300
4400	0.0337	0.150	0.05	4.00	2	6.00	2	0.078	0.102	4400
4500	0.0332	0.149	0.05	4.00	2	6.00	2	0.075	0.100	4500
4600	0.0327	0.147	0.05	4.07	2	6.08	2	0.072	0.100	4600
4700	0.0322	0.146	0.05	4.13	2	6.15	2	0.069	0.099	4700
4800	0.0318	0.144	0.05	4.20	2	6.23	2	0.066	0.099	4800
4900	0.0313	0.143	0.05	4.27	2	6.30	2	0.063	0.099	4900
5000	0.0308	0.141	0.05	4.33	2	6.38	2	0.060	0.099	5000

HEATING DEGREE DAY (HDD)	ROOF/ CEILING Max. UO-value	WALL Max. UO-value	FLOOR Max. UO-value	UNHEATED SLAB Min. R-value	FT	HEATED SLAB Min. R-value	FT	CRAWL SPACE WALL Min. U-value	BASEMENT WALL Min. U-value	HEATING DEGREE DAY (HDD)
5100	0.0303	0.139	0.05	4.40	2	6.46	2	0.060	0.098	5100
5200	0.0298	0.138	0.05	4.47	2	6.53	2	0.060	0.098	5200
5300	0.0294	0.136	0.05	4.53	2	6.61	2	0.060	0.098	5300
5400	0.0289	0.135	0.05	4.60	2	6.68	2	0.060	0.098	5400
5500	0.0284	0.133	0.05	4.67	2	6.76	2	0.060	0.097	5500
5600	0.0279	0.132	0.05	4.73	2	6.83	2	0.060	0.097	5600
5700	0.0274	0.130	0.05	4.80	2	6.91	2	0.060	0.097	5700
5800	0.0270	0.129	0.05	4.87	2	6.99	2	0.060	0.097	5800
5900	0.0265	0.127	0.05	4.93	2	7.06	2	0.060	0.096	5900
6000	0.0260	0.125	0.05	5.00	4	7.14	4	0.060	0.096	6000
6100	0.0260	0.124	0.05	5.07	4	7.21	4	0.060	0.096	6100
6200	0.0260	0.122	0.05	5.13	4	7.29	4	0.060	0.096	6200
6300	0.0260	0.121	0.05	5.20	4	7.37	4	0.060	0.095	6300
6400	0.0260	0.119	0.05	5.27	4	7.44	4	0.060	0.095	6400
6500	0.0260	0.118	0.05	5.33	4	7.52	4	0.060	0.095	6500
6600	0.0260	0.116	0.05	5.40	4	7.59	4	0.060	0.095	6600
6700	0.0260	0.115	0.05	5.47	4	7.67	4	0.060	0.094	6700
6800	0.0260	0.113	0.05	5.53	4	7.74	4	0.060	0.094	6800
6900	0.0260	0.112	0.05	5.60	4	7.82	4	0.060	0.094	6900
7000	0.0260	0.110	0.05	5.67	4	7.90	4	0.060	0.094	7000
7100	0.0260	0.110	0.05	5.73	4	7.97	4	0.060	0.093	7100
7200	0.0260	0.110	0.05	5.80	4	8.05	4	0.060	0.093	7200
7300	0.0260	0.110	0.05	5.87	4	8.12	4	0.060	0.093	7300
7400	0.0260	0.110	0.05	5.93	4	8.20	4	0.060	0.093	7400
7500	0.0260	0.110	0.05	6.00	4	8.28	4	0.060	0.092	7500
7600	0.0260	0.110	0.05	6.07	4	8.35	4	0.060	0.092	7600
7700	0.0260	0.110	0.05	6.13	4	8.43	4	0.060	0.092	7700
7800	0.0260	0.110	0.05	6.20	4	8.50	4	0.060	0.092	7800
7900	0.0260	0.110	0.05	6.27	4	8.58	4	0.060	0.091	7900
8000	0.0260	0.110	0.05	6.33	4	8.66	4	0.060	0.091	8000
8100	0.0260	0.110	0.05	6.40	4	8.73	4	0.060	0.091	8100
8200	0.0260	0.110	0.05	6.47	4	8.81	4	0.060	0.091	8200
8300	0.0260	0.110	0.05	6.53	4	8.88	4	0.060	0.090	8300
8400	0.0260	0.110	0.05	6.60	4	8.96	4	0.060	0.090	8400
8500	0.0260	0.110	0.05	6.67	4	9.03	4	0.060	0.090	8500
8600	0.0260	0.110	0.05	6.73	4	9.11	4	0.060	0.084	8600
8700	0.0260	0.110	0.05	6.80	4	9.19	4	0.060	0.078	8700
8800	0.0260	0.110	0.05	6.87	4	9.26	4	0.060	0.072	8800
8900	0.0260	0.110	0.05	6.93	4	9.34	4	0.060	0.066	8900
9000	0.0260	0.110	0.05	7.00	4	9.41	4	0.060	0.060	9000
9100	0.0260	0.110	0.05	7.07	4	9.49	4	0.060	0.060	9100
9200	0.0260	0.110	0.05	7.13	4	9.57	4	0.060	0.060	9200
9300	0.0260	0.110	0.05	7.20	4	9.64	4	0.060	0.060	9300
9400	0.0260	0.110	0.05	7.27	4	9.72	4	0.060	0.060	9400
9500	0.0260	0.110	0.05	7.33	4	9.79	4	0.060	0.060	9500
9600	0.0260	0.110	0.05	7.40	4	9.87	4	0.060	0.060	9600
9700	0.0260	0.110	0.05	7.47	4	9.94	4	0.060	0.060	9700
9800	0.0260	0.110	0.05	7.53	4	10.02	4	0.060	0.060	9800
9900	0.0260	0.110	0.05	7.60	4	10.10	4	0.060	0.060	9900
10000	0.0260	0.110	0.05	7.67	4	10.17	4	0.060	0.060	10000

CHAPTER 3 EXAMPLES OF MEC COMPLIANCE

This chapter expands on Chapters 1 and 2 by including an example of how a builder or designer would use either the Applications or Trade-Off Worksheet to verify MEC compliance.

House Example

The house selected for this example is a split-level ranch (see Fig 3), with many of the "difficulties" likely to be faced by builders seeking MEC compliance for a relatively simple house. The following questions arise: is the lower level a basement? What happens to the second floor cantilever? How is the cathedral ceiling calculated versus the flat ceiling? All are addressed here.

The house is located in Sampletown, Ohio, with a HDD of 4523. It has a floor area of 1152 sq. ft. on the lower level, with 8" concrete block walls. The upper level cantilevers over the lower level by two feet at the front (except at entry) and rear and has a total of 1292 sq. ft. (Note: the stair/landing area is figured into the lower level floor area, but not in the upper level.) The lower level is 7 ft. below grade at the rear and 3 ft. below grade at the front; its average is 5 ft below grade (i.e. more than 50% below grade).

The upper level living, dining and entry areas have a sloped cathedral ceiling with a total area of 584 sq. ft. Note that we measure the sloped surface area, which is greater than a flat ceiling area would have been. The rest of the upper level has a flat ceiling with a total area of 786 sq. ft. The entry has a skylight measuring 10 sq. ft.

The upper level exterior wall areas total 1310 sq. ft. Note that the living room end wall, with a cathedral ceiling, has gable-end wall areas which are included in this calculation. Of the exterior wall area, windows total 130 sq. ft., a slider is 45 sq. ft., and the front door is 20 sq. ft. Because basement windows and doors are included in exterior wall calculations, the lower level window area, 45 sq. ft., is then added for a total window and door area of 240 sq. ft. The lower level exterior walls (including rim joist area) total 1110 sq. ft. of which 1065 sq. ft. is opaque.

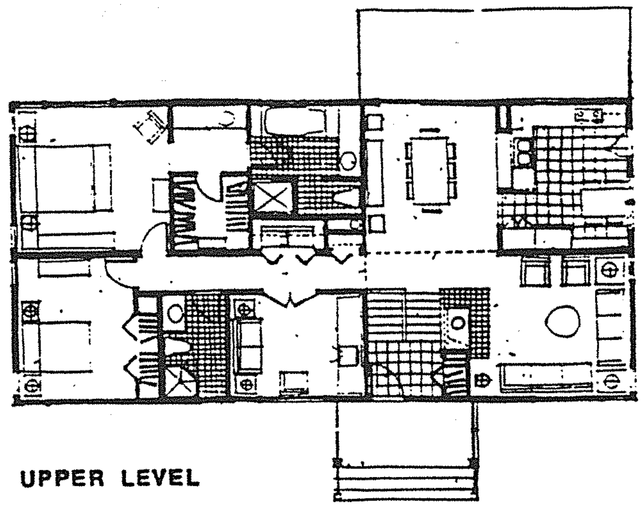
The lower level floor slab has a perimeter of 152 ft. The cantilevered upper level floor totals 196 sq. ft. in area.

Completing the Applications Worksheet

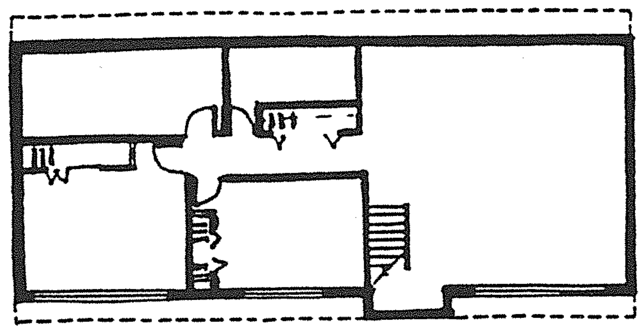
The Worksheet is completed as shown in Figure 4, below. The 4501-5000 HDD Interpretive Requirements Table on page 13 provides the minimum R_0 values for the exterior envelope components as follows:

- Roof R_0-value min = 32.47
- Floor R_0-value min = 20.00
- Basement wall R_0-value min = 10.14

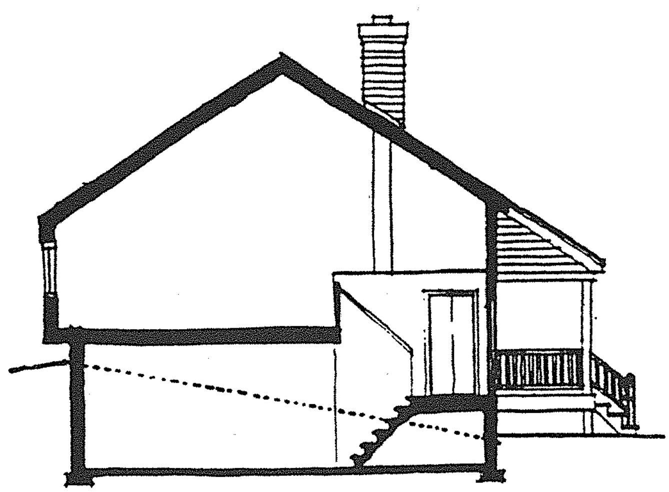
VIEW



UPPER LEVEL



LOWER LEVEL



SECTION AT ENTRY

Fig. 3 Sample House

Applications Worksheet

Builder Name: ______________________________ Date ______________
Address: ______________________________
Submitted by: ______________________________ Phone: ______________
Building Address: ______________________________
Legal Descr. Lot: ______________ Section: ________ County: ______________
General Descr. ______________________________
Local HDD __________ Building Area: __________ sf

Roof/Ceiling

Ceiling Type	Area, sf	R-value installed	System R_o From Page A-2	AreaX1/R_o	Meets MEC
Flat Ceiling					
Cathedral Ceiling					
Totals, Total "Area" and "AreaX1/R_o" columns.	______			______	
Required R_o from Appendix A-1, Compare to "Ave. R_o." If "Ave. R_o" is greater than Required R_o, check "Meets MEC" column.	______		Ave. R_o = Tot. "Area" ÷ "A X 1/R"	______	______
Skylight Percent, must be less than 1%	______				______

Openings

Opening Type	Area	R-value From Page A-3	Area X 1/R
Window Type 1			
Window Type 2			
Slider			
Basement Window			
Door			
Open Area Total Sum the "Area" and "Area X 1/R" columns.	______		______
Glazing R_o Divide total "Area" by Total "A X 1/R"	______		

Exterior Walls

				Meets MEC
Gross Wall Area		Percent Open Divide the Open Area Total by the Gross Wall Area.		
		Wall R-value Installed		
Wall R_o Required from Appendix A, Interpretive Requirements Tables. If "System R_o-value" is greater than "Wall R_o Required" Check "Meets MEC" column.	______	System R_o-value from Tables in Appendix A.	______	______

Other Components

	Required From Tables in Appendix A.		Installed Value	System R_o From Tables in Appendix A.	Meets MEC
Floor R_o					______
Slab Insulation R-value					______
Slab Insulation depth					______
Crawlspace R_o					______
Basement R_o-value					______
Other R_o					______
Other R_o					______

COMPLIANCE CERTIFICATION

This Residence Meets the 1992 Model Energy Code

______________________________ ______________ ______________
Builder/Designer Company Name Date

______________________________ ______________ ______________
Building Official Jurisdiction Date

Trade Off Worksheet

Builder Name: ______________________ Date ________
Address: ______________________
Submitted by: ______________________ Phone: ________
Building Address: ______________________
Legal Descr.Lot: ______________ Section: ______ County: ________
Local HDD ________ Building Area: ________ sf

YOUR HOUSE | **CODE HOUSE**

Roof/Ceiling

	Area, sf	R_o From Tables in Appendix A	Area X 1/R_o				
Ceiling/Attic							
Cathedral							
Skylight							
Total	____				Area	Required R from A-1	AreaX1/R
Total Area X 1/R Sum the "Area X 1/R_o" Column			____		____	____	____

Wall

Opening Type	Area, sf	R_o From Tables in Appendix A	Area X 1/R_o				
Window, Type 1							
Window, Type 2							
Slider							
Basement Window							
Door							
Other							
Opaque Area							
Total	____				Area	Required R From A-1	Area X 1/R
Total Area X 1/R							

Floor

	Area, sf	R_o From Tables in Appendix A	Area X 1/R_o		Area	R	Area X 1/R
Floor Over Crawlspace							
Cantilevered Floor							
Slab Ht? Unht?							
Slab	Perim X Depth __ x __	R __			PerimXDepth __x__	R	
Total Area X 1/R							

Basement Wall

	Area, sf	R_o From Tables in Appendix A	Area X 1/R_o		Area, sf	Required R From Code	Area X 1/R
Opaque Area							

Crawlspace Wall

	Area, sf	R_o From Tables in Appendix A	Area X 1/R_o		Area, sf	Required R From Code	Area X 1/R
Opaque Area							

Totals, Roof/Clg, Walls, Floors, Basement Walls, Crawlspace Walls	____		**Totals, Roof/Clg, Walls, Floors, Basement Walls, Crawlspace Walls**	____

If the total for YOUR HOUSE is less than the total for CODE HOUSE, your house is in compliance.

COMPLIANCE CERTIFICATION This Residence Meets the 1992 Model Energy Code

______________________ ______________ ________
Builder/Designer Company Name Date

______________________ ______________ ________
Building Official Jurisdiction Date

ACCEPTABLE PRACTICE COMPLIANCE

Walls

w/Single Glazing

1. Gross Wall Area _____SF
2. Glazing Area _____SF
3. Door Area _____SF
4. Line 3 times 1/2 _____SF
5. Line 2 + Line 4 _____SF
6. Line 5 / Line 1 _____%
7. U_w (wall detail) _____
8. U_o Wall (graph) _____
9. U_o Wall (Code) _____

w/Double Glazing

1. Gross Wall Area ______SF
2. Glazing Area ______SF
3. Door Area ______SF
4. Line 2 + Line 3 ______SF
5. Line 4 / Line 1 ______%
6. U_w (wall detail) ______
7. U_o Wall (graph) ______
8. U_o Wall (Code) ______

Roof/Ceilings

1. Gross Ceiling Area _____SF
2. Glazing Area _____SF
3. Line 2 / Line 1 _____*
4. U_r (Roof Detail) _____
5. U_o Roof (Code) _____

Floors Over Unheated Space

1. Gross Floor Area ______SF
2. U_f (floor detail) ______
3. U_o Floor (Code) ______

* If Line 3 under Roof/Ceilings is greater than 0.01, design cannot be complied with by the Acceptable Practice path.

U_o CALCULATIONS FOR WALLS - ____________

TABLE W-1

	COLUMN A (SF)		COLUMN B (U)		COLUMN C (SF x U)
1. Gross Wall Area (A_o)					
2. Window Area (A_g)		x		=	
3. Door Area (A_d)		x		=	
4. Other Wall Component (Specify)		x		=	
5. Opaque Wall Area (Col. A, Line 1 - Col. A, Lines 2, 3 & 4)					
6. Framing (A_{fr}) (SF = Col. A, Line 5 x Table W-2)		x		=	
7. Cavity (A_c) (SF = Col. A, Line 5 x Table W-2)		x		=	
			TOTAL		

$$U_o = \frac{U_1A_1 + U_2A_2 + U_3A_3 \ldots + U_nA_n}{A_o}$$

$$U_o \text{ Wall} = \frac{\text{Total Col. C}}{\text{Col. A, Line 1}} = \square$$

TABLE W-3

OPAQUE WALL CALC. (FRAMING & CAVITY)		
(R VALUES)	FRAMING R	CAVITY R
8. Outside Air Film		
9. Exterior Finish		
10. Outside Sheathing		
11. Framing		X
12. Cavity (a) Insulation (b) Airspace	X	
13. Interior Finish		
14. Inside Air Film		
15. Other (Specify)		
16. Total R_T (Sum Lines 8 thru 15)		
17. U_{fr} Framing = $1/R_T$		X
18. U_c Cavity = $1/R_T$	X	

TABLE W-2
FRAMING & CAVITY AREAS

Stud Spacing	Framing	Cavity
12"	0.17	0.83
16"	0.15	0.85
24"	0.10	0.90

TABLE W-4

19. Windows U_g =	

TABLE W-5

20. Doors U_d =	

TABLE W-6
OTHER (SPECIFY)

21. R Value	
22. U = 1/R =	

U_o CALCULATIONS FOR ROOFS/CEILINGS

TABLE R-1

	COLUMN A (SF)		COLUMN B (U)		COLUMN C (SF x U)
1. Gross Roof Area (A_o)					
2. Skylight Area (A_s)		x		=	
3. Other (Specify)		x		=	
4. Opaque Roof Area (Col. A, Line 1 - Col. A, Lines 2 & 3)					
5. Framing (A_{fr}) (SF = Col. A, Line 4 x Table R-2)		x		=	
6. Cavity (A_c) (SF = Col. A, Line 4 x Table R-2)		x		=	
			TOTAL		

$$U_o = \frac{U_1A_1 + U_2A_2 + U_3A_3 \ldots + U_nA_n}{A_o}$$

$$U_o \text{ Roof} = \frac{\text{Total Col. C}}{\text{Col. A, Line 1}} = \square$$

TABLE R-3

OPAQUE ROOF CALC. (FRAMING & CAVITY)		
(R VALUES)	FRAMING R	CAVITY R
7. Outside Air Film		
8. Exterior Finish		
9. Sheathing		
10. Framing		X
11. Cavity (a) Insulation (b) Airspace	X	
12. Interior Finish		
13. Inside Air Film		
14. Other (Specify)		
15. Total R_T (Sum Lines 7 thru 14)		
16. U_{fr} Framing = $1/R_T$		X
17. U_c Cavity = $1/R_T$	X	

TABLE R-2
FRAMING & CAVITY AREAS

Framing Spacing	Framing	Cavity
12"	0.13	0.87
16"	0.10	0.90
24"	0.06	0.94

TABLE R-4

18. Skylight U_s =	

TABLE R-5
OTHER (SPECIFY)

19. R Value	
20. U = 1/R =	

U_o CALCULATIONS FOR FLOORS

TABLE F-1

	COLUMN A (SF)		COLUMN B (U)		COLUMN C (SF x U)
1. Gross Floor Area (A_o)					
2. Other (Specify)		x		=	
3. Opaque Floor Area (Col. A, Line 1 - Col. A, Line 2)					
4. Framing (A_{fr}) (SF = Col. A, Line 3 x Table F-2)		x		=	
5. Cavity (A_c) (SF = Col. A, Line 3 x Table F-2)		x		=	
			TOTAL		

$$U_o = \frac{U_1A_1 + U_2A_2 + U_3A_3 \ldots + U_nA_n}{A_o}$$

$$U_o \text{ Roof} = \frac{\text{Total Col. C}}{\text{Col. A, Line 1}} = \boxed{}$$

TABLE F-3

OPAQUE FLOOR CALC. (FRAMING & CAVITY)

(R VALUES)	FRAMING R	CAVITY R
6. Outside Air Film		
7. Framing		X
8. Cavity (a) Insulation (b) Airspace	X	
9. Subfloor		
10. Finish Floor		
11. Carpet/Tile		
12. Inside Air Film		
13. Other (Specify)		
14. Total R_T (Sum Lines 6 thru 13)		
15. U_{fr} Framing = $1/R_T$		X
16. U_c Cavity = $1/R_T$	X	

TABLE F-2
FRAMING & CAVITY AREAS

Framing Spacing	Framing	Cavity
12"	0.13	0.87
16"	0.10	0.90
24"	0.06	0.94

TABLE F-4
OTHER (SPECIFY)

17. R Value
18. U = 1/R =

ERRATA SHEET 1 - EFFECTIVE OCTOBER 1, 1994

CHAPTER 53

ENERGY CONSTRUCTION IN NEW BUILDINGS

General

Sec. 5301.

(a) **Purpose.** The purpose of this appendix is to regulate the design and construction of the exterior envelopes and selection of heating, ventilating and air-conditioning, service water heating, electrical distribution and illuminating systems and equipment required for the purpose of effective conservation of energy within a building or structure governed by this code.

(b) **Model Energy Code Adopted.** In order to comply with the purpose of this appendix, buildings shall be designed to comply with the requirements of the Model Energy Code promulgated jointly by the International Conference of Building Officials (ICBO), the Southern Building Code Congress International (SBCC), the Building Officials and Code Administrators International (BOCA), and the National Conference of States on Building Codes and Standards (NCSBCS), dated 1992.

RESIDENTIAL EXCEPTIONS

1. Compliance paths as provided by the New Mexico Department of Energy and Minerals Energy Conservation Code Applications Manual are allowed to demonstrate compliance. This manual is further adopted by reference as a Guideline Standard to Part XI, Chapter 60, UBC Standard, Part III, Guideline Standards.

2. Up to 1% (one percent) of the total heated square footage is allowed to be installed with double-wall, double-dome, or insulated skylights complying with Chapter 34 and be exempt from the calculation requirement of the MEC.

3. For slab-on-grade installations, the placement of vertical perimeter insulation shall not be required to penetrate the top four inches (4") of the slab at
   (a) door thresholds.
   (b) between unheated garages, storage or mechanical areas and heated living spaces.

   Horizontal, sub-slab placement of insulation in these locations shall be allowed.

4. The required depth and placement of perimeter insulation shall not be required to a depth that exceeds that of the top of the spread footing or the bottom of the monolithically-poured footing. Where this condition occurs in areas of 6,000 heating degrees days or greater, additional insulation to meet MEC minimums shall be allowed to be placed horizontally under the adjacent slab.