

THERMAL PERFORMANCE
CONSTRUCTION STANDARDS

I. PURPOSE: This Exhibit prescribes thermal performance construction standards to be used in all housing loan and grant programs. These requirements shall supersede the thermal performance requirements in any of the development standards in § 1924.4(h) of this subpart.

II. POLICY: All loan or grant applications involving new construction (except for new Single Family Housing (SFH)) and all applications for conditional commitments (except for new SFH) shall have drawings and specifications prepared to comply with paragraphs IV A or C and IV D of this Exhibit. All new SFH construction shall have drawing and specifications prepared to comply with paragraph IV F of this Exhibit.

III. DEFINITIONS:

A. British thermal unit (Btu) means the quantity of heat required to raise the temperature of one pound (.4535 KM.) of water by one degree Fahrenheit (F). For example, one Btu is the amount of heat needed to raise the temperature of one pound of water from 59 degrees F to 60 degrees F.

B. Glazing is the material set into a sash or door when used as a natural light source and/or for occupant's views of the outdoors.

C. "R" value, thermal resistance, is a unit of measure of the ability to resist heat flow. The higher the R value, the higher the insulating ability.

D. "U" value is the overall coefficient of heat transmission and is the combined thermal value of all the materials in a building section. U is the reciprocal of R. Thus $U = 1/R$ or $R = 1/U$ or $1/C$ where C is the thermal conductance and is the unit of measure of the rate of heat flow for the actual thickness of a material one square foot in area at a temperature of one degree Fahrenheit. The lower the U value, the higher the insulating ability.

E. Winter degree-day is a unit based on temperature difference and time. For any one day, when the mean temperature is less than 65 degrees F (18.3 degrees Celsius), there are as many degree-days as the number of degrees difference between the mean temperature for the day and 65 degrees F. The daily mean temperature is computed as half the total of the daily maximum and daily minimum temperatures.

F. CABO MODEL ENERGY CODE, 1992 EDITION (MEC-92) - This code sets forth the minimum energy/thermal requirements for the design of new buildings and structures or portions thereof and additions to existing buildings. The MEC is maintained by the Council of American Building Officials (CABO).

IV. MINIMUM REQUIREMENTS

A. All multifamily dwellings to be constructed with Rural Development loan and/or grant funds and all repair, remodeling, or renovation work performed on single family and multifamily dwellings with Rural Development loan and/or grant funds shall be in conformance with the following, except as provided in paragraphs IV C 3 and IV D of this Exhibit:

NEW CONSTRUCTION
MAXIMUM U VALUES FOR CEILING, WALL, AND FLOOR
SECTION OF VARIOUS CONSTRUCTION

| Winter Degree Days (Note 1) | Ceilings (Note 2) | Walls | Floors (Note 3) | Glazing (Note 4) | Doors (Note 5) |
|-----------------------------|-------------------|-------------------|-----------------|------------------|---|
| 1000 or less | .05 | .08 | .08 | 1.13 | ---- |
| 1001 to 2500 | .04 | .07 | .07 | .69 | ---- |
| 2501 to 4500 | .69 | if over 25% glass | | | Storm door if hollow core door .03 .05 |
| 4501 to 6000 | .03 | .05 | .05 | .47 | Storm Door |
| 6001 or more | .026 | .05 | .05 | .47 | Storm Door |

(U values are not adjusted for framing. Values calculated for components may be rounded. For example, a total R Value of 18.88 converts to a U value of .0529 rounded to .05)

Note 1. Winter degree-days may be obtained from the ASHRAE Handbook; the "NAHB insulation Manual for Homes/Apartments"; local utilities; and the National Climatic Center, Federal Building, Asheville, NC. Manuals are available from NAHB RF, Rockville, MD 20850, or NMWIA, 382 Springfield Avenue, Summit, NJ 07901. Other sources of degree day data may be used if available from a recognized authority.

Note 2. Insulation must be continuous (i.e. no gaps) above all ceiling joists. In pitched roof construction, compression of insulation at the outside building walls is permitted to allow a 1" ventilation space under the roof sheathing. For any loose fill insulation, a baffle must be provided. Raised trusses are not required.

Note 3. For floors of heated spaces over unheated basements, unheated garages or unheated crawl spaces, the U value of floor section shall not exceed the value shown. A basement, crawl space, or garage shall be considered unheated unless it is provided with a positive heat supply to maintain a minimum temperature of 50 degrees F. Positive heat supply is defined by ASHRAE as heat supplied to a space by design or by heat losses occurring from energy-consuming systems or components associated with that space."

Where the walls of an unheated basement or crawl space are insulated in lieu of floor insulation, the total heat loss attributed to the floor from the heated area shall not exceed the heat loss calculated for floors with required insulation.

Insulation may be omitted from floors over heated basement areas or heated crawl spaces if foundation walls are insulated. The U value of foundation wall sections shall not exceed the value shown. This requirement shall include all foundation wall area, including header joist (band joist), to a point 50 percent of the distance from a finish grade to the basement floor level. Equivalent Uo configurations are acceptable.

MAXIMUM U VALUES OF THE FOUNDATION WALL Sections OF HEATED BASEMENT NOT CONTAINING HABITABLE LIVING AREA OR HEATED CRAWL SPACE

| Winter Degree Days (65 F Base) | Maximum U Value | Glazing* |
|-----------------------------------|-----------------|----------|
| 2500 or less | No requirement | 1.13 |
| 2501 to 4500 | 0.17 | 1.13 |
| 4501 or more | 0.10 | 0.69 |

*Glazing in heated basement shall be limited to 5 percent of floor area unless alternative Uo combination is documented.

Note 4. Sliding glass doors are considered as glazing. The glazing value is for glass only. Glazing shall be limited to 15 percent of the gross area of all exterior walls enclosing heated space, except when demonstrated that the winter daily solar heat gain exceeds the heat loss and the glass area is properly screened from summer solar heat gain.

Note 5. 1-3/4 inch metal-faced door systems with rigid insulation core and durable weatherstripping providing a "U" value equivalent to a wood door with storm door and an infiltration rate no greater than .50 cfm per foot of crack length tested according to ASTM E-283 at 1.567 psf of air pressure, may be substituted for a conventional door and storm door. All doors shall be weatherstripped. Any glazed areas must be double-glazed.

MINIMUM R VALUES OF PERIMETER INSULATION FOR SLABS-ON-GRADE

| Winter Degree-Days (65 F Base) | Minimum R Values* | |
|-----------------------------------|-------------------|---------------|
| | Heated Slab | Unheated Slab |
| 500 or less | 2.8 | ---- |
| 1000 | 3.5 | ---- |
| 2000 | 4.0 | 2.5 |
| 3000 | 4.8 | 2.8 |
| 4000 | 5.5 | 3.5 |
| 5000 | 6.3 | 4.2 |
| 6000 | 7.0 | 4.8 |
| 7000 | 7.8 | 5.5 |
| 8000 | 8.5 | 6.2 |
| 9000 | 9.2 | 6.8 |
| 10000 or greater | 10.0 | 7.5 |

*For increments between degree days shown, R values may be interpolated.

B. [Reserved]

C. Optional Standards. Housing design not in compliance with the requirements of paragraph IV A of this Exhibit may be approved in accordance with the provisions of this paragraph. Requests for acceptance proposed under paragraph C 1 below, must be approved by the State Director. Requests for acceptance of site-built housing proposed under paragraph C 2 must be approved by the Administrator. Requests for acceptance of manufactured housing proposed under paragraph C 2 may be approved by the State Director. All submissions of proposed options to the State Director or Administrator shall contain complete descriptions of materials, engineering data, test data (when U values claimed are lower than the ASHRAE Handbook of Fundamentals), and calculations to document the validity of the proposal. All data and calculations will be based upon the current edition of the ASHRAE Handbook of Fundamentals or other universally accepted data sources.

1. Overall "U" values for envelope components. The following requirements shall be used in determining acceptable options to the requirements of paragraph IV A of this Exhibit.

a. U_o (gross wall) - Total exterior wall area (opaque wall and window and door) shall have a combined thermal transmittance value (U_o value) not to exceed the values shown in Attachment 1 to this Exhibit D (available in any Rural Development office). Equation 1 in Attachment 1 shall be used to determine acceptable combinations to meet the requirements.

b. U_o (gross ceiling) - Total ceiling area (opaque ceiling and skylights) shall have a combined thermal transmittance value (U_o value) not to exceed the values shown in Attachment 2 to this Exhibit D (available in any Rural Development office). Equation 2 in Attachment 2 shall be used to determine acceptable combinations to meet the requirements.

2. Overall structure performance. The following requirements shall be used in determining acceptable options to the requirements of paragraph IV A of this Exhibit.

a. The methodology must be cost effective to the energy user, and must not adversely affect the structural capacity, durability or safety aspects of the structure.

b. All data and calculations must show valid performance comparisons between the proposed option and a structure

comparable in size, configuration, orientation and occupant usage designed in accordance with paragraph IV A. Structures may be considered for Rural Development loan consideration which can be shown by accepted engineering practice to have energy consumption equal to or less than those which would be attained in a representative structure utilizing the requirements of paragraph IV A.

3. Special consideration for seasonally occupied farm labor housing. The following sets forth the minimum acceptable options to the requirements of paragraph IV A of this Exhibit for seasonally occupied housing serving as security for farm labor housing loans and grants.

a. When the period of occupancy does not encounter 500 or more heating degree-days (HDD) as determined by an average of the previous 10 years based upon local climatological data published by the National Oceanic and Atmospheric Administration, Environmental Data Service, the standards of paragraph IV A will not apply.

b. When the period of use exceeds 500 HDD, the 10-year average value for the period of occupancy shall be used to determine the degree to which the thermal insulation requirements of paragraph IV A shall apply.

c. If mechanical cooling is provided and the period of occupancy encounters more than 700 cooling degree-days (CDD), as determined by an average of the previous 8 years based upon local climatological data published by the same source cited in paragraph IV C 3 a above, the thermal insulation requirements for 1,000 and less degree-days as stated in paragraph IV A shall apply.

D. Energy efficient construction practices. This section prescribes those items of design and quality control which are necessary to guarantee the energy efficiency of homes built according to the standards of this Exhibit. Also included are recommendations for extra energy efficiency in dwellings. This section does not apply to new SFH construction.

1. Infiltration.

a. Requirements: All construction shall be performed in such a manner as to provide a building envelope free of excessive infiltration.

(i) Caulking and sealants. Exterior joints around windows and door frames, between wall cavities and window or door frames, between wall and foundation, between wall and roof, between wall panels, at penetrations of utility services through walls, floors and roofs, and all other openings in the exterior envelope shall be caulked, gasketed, weatherstripped, or otherwise sealed. Caulking shall be silicone rubber base or butyl rubber base, conforming to Federal Specifications TT-S-1543 and TT-S-1657 respectively, or materials demonstrating equivalent performance in resilience and durability.

(ii) Windows shall comply with ANSI 134.1, NWMA 15-2; the air infiltration rate shall not exceed 0.5 ft³/min per ft. of sash crack.

(iii) Sliding glass doors shall comply with ANSI 134.2, NWMA 15-3; the air infiltration rate shall not exceed .5 ft³/min per square ft. of door area.

(iv) All insulation placed in open cavity walls shall be installed so that all space behind electrical switches and receptacles, plumbing, ductwork and other obstructions in the cavity are insulated as completely as possible. Insulation shall be omitted on the side facing the conditioned area; however, the vapor barrier in walls must not be cut or destroyed.

b. Recommendations:

(i) Wrap outside corners of wall sheathing with 15 lb. Asphalt impregnated building felt before siding application.

(ii) Utilize vestibules for entry doors, especially those facing into the direction of winter wind.

(iii) Install plumbing, mechanical and electrical components in interior partitions as much as possible. All water piping should be insulated from freezing temperatures.

2. Heating and/or Cooling Equipment.

a. Requirements: All mechanical equipment for heating and/or cooling habitable space shall be designed to provide economy of operation.

(i) All space heating equipment (including fireplaces) requiring combustion air shall be sealed combustion types, or be located in a nonconditioned area (such as heated basements) or adequate combustion air must be provided from outside the conditioned space.

(ii) All ductwork shall be designed and installed to minimize leakage. All metal to metal connections shall be mechanically joined and taped.

b. Recommendations:

(i) Whenever possible, locate ductwork inside of conditioned areas in dropped ceilings, interior partitions or other similar areas.

(ii) Locate outside cooling units in areas not subject to direct sunlight or heat buildup.

3. Vapor Barrier.

a. Requirements: Adequate vapor barriers must be provided adjacent to the interior finish material of the wall or other closed envelope components which do not have ventilation space on the nonconditioned side of the insulation.

(i) A vapor barrier at the inside of the wall or other closed envelope component must have a permeability (perm) rating less than that of any other material in that component and in no case have a perm rating greater than one. All vapor barriers must be sealed around all openings in the interior surface. Vapor barriers are not required in ceilings and floors. Continuous vapor barriers on ceilings, walls, and floors require adequate moisture vapor control in the conditioned space.

(ii) All vapor producing or exhaust equipment shall be ducted to the outside and equipped with dampers. This equipment includes rangehoods, bathroom exhaust fans, and clothes dryers. If a dwelling design proposes the use of windows to satisfy the kitchen and/or bathroom ventilation

requirements of the development standards, the incorporation of dehumidification equipment should be considered in accordance with paragraph IV D 3 b. Exhaust of any equipment shall not terminate in an attic or crawl space.

b. Recommendation: Forced air heating/cooling systems should include humidification/dehumidification systems where conditions indicate.

E. [Reserved]

F. New SFH construction. New SFH construction shall meet the requirements of CABO Model Energy Code, 1992 Edition (MEC-92).

G. New Manufactured Housing. The Uo Value Zone indicated on the "Heating Certificate" for comfort heating shall be equal to or greater than the HUD Zone listed in the following table:

| RHS Climate Zones (winter degree days) | FMHCSS (HUD Code) Uo Value Zones |
|---|-------------------------------------|
| 0 - 1000 | 1 |
| 1001 - 2500 | 2 |
| 2501 - 4500 | 2 |
| 4501 - 6000 | 3 |
| > 6000 | 3 |

EXAMPLE: If a manufactured home is to be located in a geographic area having between 2501 and 4500 RHS winter degree days, the Agency will accept a Uo value Zone 2 unit or Zone 3 unit constructed to the HUD Federal Manufactured Home Construction and Safety Standard (FMHCSS).

If a central air conditioning system is provided by the home manufacturer a "Comfort Cooling Certificate" must be permanently affixed to an interior surface of the unit that is readily visible. This certificate may be combined with the heating certificate on the data plate.

V. GENERAL DESIGN RECOMMENDATIONS:

A. Orient homes with greatest glass area facing south with adequate overhangs to control solar gain during non-heating periods. Examples of proper roof overhangs are given in Attachment 3 to this Exhibit D (available in any Rural Development office).

B. Arrange plantings with evergreen wind buffers on north side and deciduous trees on south.

C. Whenever possible, orient entry door away from winter winds.

D. Design house with simple shape to minimize exterior wall area.

E. Minimize glass areas within constraints of required light and ventilation, applicable safety codes, and other appropriate consideration.

F. Minimize the amount of paved surface adjacent to the structure where heat gain is not desirable.

VI. STATE SUPPLEMENTS: State supplements or policy will not be issued or adopted to either supplement or set requirements different from those of this Exhibit without the prior written approval of the National Office.