STATE OF ALASKA

BUILDING ENERGY EFFICIENCY STANDARD

September 1, 1991

State of Alaska

Walter J. Hickel, Governor

DEPARTMENT OF COMMUNITY AND REGIONAL AFFAIRS
ASSISTING ALASKAN COMMUNITIES

Department of Community & Regional Affairs

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CHAPTER 1

TITLE, SCOPE, AND GENERAL

1.1 Title

This document, dated September 1, 1991, shall be known as the "Building Energy Efficiency Standard" and is referred to herein as this "Standard."

1.2 Purpose

The purpose of this Standard is to promote the construction of energy-efficient buildings. This document sets standards for thermal resistance, air leakage, moisture protection, and ventilation as they relate to efficient use of energy in buildings.

1.3 Policies

In the implementation, administration, and enforcement of this Standard, the policy of the State of Alaska is to:

a. Foster housing that is comfortable, healthy, and affordable to heat;

b. Develop public awareness of energy efficient building designs, technologies, and systems;

c. Establish acceptable and appropriate energy standards for buildings based upon practical and cost-effective measures that reduce energy consumption;

d. Permit flexibility in compliance by allowing alternative methods of meeting the requirements of this Standard; and

e. Except where stated otherwise in this Standard, a review and monitoring of this Standard and its administration will be done every three years to make it responsive to users, technological developments, and other changes in the building industry.

1.4 Scope

This Standard shall not be used to abridge any structural, safety, fire, health, or environmental requirements of locally adopted codes, Federal standards, or current editions of the Uniform Building, Mechanical, Plumbing, and Fire Codes as adopted by the International Conference of Building Officials (ICBO) and the National Electrical Code as adopted by the National Fire Protection Association. In case of conflict between this Standard and any of the above codes or standards, the most stringent shall apply. This Standard is intended to supplement these codes.

1.5 Compliance Methods

One of four alternative methods shall be used to comply with this standard. These methods are:

Prescriptive Method - Chapter 3. This method requires minimum R-values for each thermal envelope assembly. R-values for things such as sheetrock, paint, carpeting, paneling, sheathing, siding, brick facing, interior and exterior boundary air films, or backfill shall not be included. Only insulation R-values and air spaces provided specifically for insulating value may be included.

This method shall not be used to trade-off R-value requirements between different envelope assemblies or between different components of the same assembly. To do that, Chapter 4, 5, or 6 shall be used.

When using the Prescriptive Method, all mandatory measures given in Chapter 2 shall also be accomplished.

Performance Method - Chapter 4. The Performance Method allows the trade-off of insulation requirements between elements within a particular thermal envelope assembly. For example, if window area above the allowed 15 percent prescriptive maximum is desired, the Performance Method allows such an increase provided the wall insulation R-value is increased to offset the extra heat loss resulting from the increased window area.

Trade-offs between different thermal envelope assemblies are not allowed with this method. In other words, more insulation in the ceiling does not allow for decreased insulation in the wall. For this kind of trade-off, Chapter 5, Building Budget Method or Chapter 6, Energy Rating Method shall be used. The Performance Method, however, may be used in combination with the Prescriptive Method.

Some calculations are necessary with the Performance Method. The formulas to calculate trade-offs are provided in this Chapter.

When using the Performance Method, all mandatory measures given in Chapter 2 shall also be accomplished.

Building Budget Method - Chapter 5. The Building Budget Method requires proof of compliance through a HOT-2000 computer energy use analysis or manual calculations. This option requires calculating space heat loss values. Specific insulation requirements are not given. Any design may be chosen, provided the building does not exceed the maximum energy use and heat loss values given for the region and building type. When using this option, all mandatory measures given in Chapter 2 shall also be accomplished.

Energy Rated Homes Method - Chapter 6. This option currently requires achieving a *Four Star* Energy Rated Homes of Alaska rating and complying with the ventilation requirements given in this Standard. On January 1, 1995 the requirement shall be increased to a *Four Star Plus* rating. The energy rating shall be done by a certificated Energy Rated Homes of Alaska rater.

1.6 Alternate Materials And Construction Methods

The provisions of this Standard do not prevent the use of a material or method of construction not specifically prescribed by this Standard provided the alternative has been approved and its use authorized as complying with this Standard by the Rural Development Division of the

Department of Community and Regional Affairs. The Division will require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding alternatives. The details of any action granting approval of an alternate will be recorded and entered in the files of the Division.

CHAPTER 2

MANDATORY DESIGN MEASURES

Energy efficiency involves insulating the thermal envelope, installing the vapor retarder carefully, providing proper ventilation, installing high efficiency heating appliances, caulking, sealing, and weather stripping, and applying many other measures that together make a complete, unified system.

This chapter specifies mandatory energy conservation measures. These measures shall also be complied with when using Chapter 3, 4, or 5 to demonstrate compliance with this Standard. This chapter may be used as a guide for building to ensure compliance with Chapter 6.

2.1 Insulation

Thermal insulation is the primary material that resists the flow of heat out of a heated building. There are many kinds of insulation. Specific application, ability to resist heat flow, flame spread, smoke developed, and other factors vary for each. Insulation installation shall be as recommended by the manufacturer and approved by local building codes.

The following requirements govern the use of a thermal insulation material:

a. A recessed light fixture may be installed in an insulated cavity provided the fixture is labeled for such installation by an appropriate agency, such as Underwriters Laboratory. A fixture shall not break the continuity of a vapor retarder.

b. An insulation material shall not be installed within 2 inches of a concrete or masonry chimney unless the insulation is designated as noncombustible and approved for such installation by the insulation manufacturer and local building codes.

c. Clearance around a gas flue vent or metal chimney shall comply with provisions of the appropriate ICBO codes.

d. A noncombustible material shall be installed to permanently maintain required clearances of thermal insulation from a heat source.

e. A pipe, wire, electric box or other object in an insulated cavity shall have insulation shaped and installed around the object rather than compressed behind it or shifted out of place because of it.

f. An insulation material shall not be installed in any manner that obstructs an opening required for attic ventilation.

g. If eave baffles are necessary to maintain required attic ventilation, they shall be wood, metal, moisture resistant cardboard, or other such material that can be fixed, is rigid, weather resistant, and non-collapsible. A baffle shall provide a minimum clear air space of 1.5 inches above the baffle the full width between roof rafters. An eave baffle itself or solid blocking shall shield the face of the insulation to prevent wind from blowing through an eave vent directly into the insulation. Do not extend an impermeable baffle, such as plastic coated cardboard, the full length of the ceiling. This creates a double vapor retarder problem. See Section 2.8 for more information on permeability requirements of outer envelope materials.

h. Loose fill insulation in ceilings that slope more than 2.5 inches in 12 inches requires a glue binder, netting, or other means recommended by the insulation manufacturer to prevent any settling or slumping of the insulation over time.

i. Loose fill insulation shall meet or exceed the insulation manufacturer's recommended installed density to achieve a required R-value.

j. A corner of an exterior wall or a juncture where an interior wall meets an exterior wall shall be fully and properly insulated.

k. A standard raised heel truss design shall maintain the required insulation level all the way to the outer line of the building envelope.

> **Exception:** A required insulation level may be reduced in an area over a top plate of an envelope wall to accommodate a differing roof design provided the reduction is no more than 20 percent of the required R-value.

l. A drop chord truss design, where the top of the insulation is above the level of the envelope wall top plate, shall extend the insulation all the way to the outside of the envelope wall.

m. Some roof insulation designs create "warm roof" conditions. Warm roofs can result in condensation and ice-dam problems. Designers and builders should know the difference between warm roofs and cold roofs and the appropriate application of each.

2.2 Vapor Retarder

The following requirements govern a vapor retarder:

a. A continuous vapor retarder shall be installed throughout a building's thermal envelope, including rim joist areas between floors, except as permitted in Paragraph h.

b. A vapor retarder shall be installed at a point between the room interior surface and the theoretical winter dew point within each envelope assembly. The dew point shall be determined using 70° fahrenheit and 40 percent relative humidity for interior conditions, and outside temperature of January average minimum (30 year average) for the building location. See the Building Energy Efficiency Standard Workbook for weather data or use other recognized weather data sources.

c. A vapor retarder shall have a dry cup perm rating of 0.6 or less.

d. Different vapor retarder materials may be used throughout a structure provided the joint between them is sealed, gasketed, or overlapped to provide for continuous coverage as required above. For example, a ceiling and wall vapor retarder may be polyethylene while a floor vapor retarder may be exterior grade plywood with joints caulked.

e. All penetrations, punctures, or tears of a vapor retarder shall be carefully sealed. Sealing can be done with acoustical caulk, gaskets, polyethylene tape, or other products made especially for sealing a vapor retarder. Select a proper sealing material for the intended application. For example, latex, oil-based, or silicone caulks lose their sealing ability over time and should not be used to seal a vapor retarder. In most situations, acoustical caulk has proven to be an effective sealant. Sealing over solid backing is recommended.

f. Where seams in polyethylene vapor retarders are parallel to framing members, they shall be overlapped a minimum of one framing member. Where seams face an air space or do not occur over solid backing, such as a seam perpendicular to framing members, they shall be sealed with vapor retarder tape. Where seams are sandwiched between rigid materials, such as between framing and gypsum wallboard, they do not need to be sealed (although it is recommended). Duct tape shall not be used for any sealing.

g. A polyethylene vapor retarder shall not be drawn tightly across framing members before fastening. Slack in the polyethylene shall be provided to allow for expansion, contraction and movement of structural members.

h. A vapor retarder is not required for a crawl space wall.

i. A vapor retarder of minimum 6 mil (0.006 inches) thick polyethylene or approved equal shall be laid over the ground within a crawl space. A vapor retarder shall be overlapped 12 inches minimum at all joints and shall extend up the crawl space wall a minimum of 12 inches. It is recommended that the vapor retarder be protected from punctures or tears by covering it with a two-inch layer of concrete or sand.

2.3 Air Tightness

Cracks, joints, and openings in a building's thermal envelope can be the cause of as much as 40 to 50 percent of a building's total heat loss. This Standard contains a number of measures to minimize uncontrolled air movement through a thermal envelope. Controlling random air movement and providing controlled ventilation is the best way to reduce air leakage and heating costs, reduce the infiltration of radon, protect the building structure, and provide needed fresh air.

One of the three methods below shall be used for compliance with air tightness requirements for this Standard:

a. *Sealing Measures.* All cracks, joints, and openings in or through a thermal envelope shall be caulked, gasketed, taped, weather-stripped, or otherwise sealed. Such locations include, but are not limited to:

- Between rough framing and a window or a door frame, between an exterior wall sole (bottom) plate and floor, between a mudsill and a foundation wall;
- Around a utility penetration such as for plumbing, electricity, telephone or fuel line;
- Around a penetration in a ceiling or floor such as for a chimney, flue, vent, attic access panel, or crawl space access panel;

- At a break, penetration, puncture, or tear in a vapor retarder (as stated in Section 2.2, Vapor Retarder);
- At a hole in a stud or top or bottom plate of an interior or exterior wall where piping or electric wiring pass through the thermal envelope;
- Around an electric outlet or junction box;
- Around an HVAC duct;
- Around a fan enclosure, supply or exhaust grill, or diffuser;
- At all other such openings in the thermal envelope.

A caulking, gasket, or sealing material and the manner in which it is applied shall conform to applicable ICBO codes and the manufacturer's recommendations. Stuffing fiberglass insulation into a crack is not an adequate sealing method.

b. *Blower Door Testing.* Air tightening may be accomplished in any manner provided total air changes per hour (ACH) for a building does not exceed the value given in Table 2.1 when tested in accordance with the ASTM (American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103) E779-87 "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization" or the Canadian CAN/CGSB-149.10-M86 "Standard for Determination of Airtightness of Buildings by the Fan Depressurization Method."

Table 2.1
Airtightness Requirements
@ 50 Pascals

Building Type	Region	ACH
Detached single-family or duplex	1, 2, & 3	4
Detached single-family or duplex	4 & 5	3
All other	All	3

c. *Tracer Gas Testing.* Air tightening may be accomplished in any manner provided total natural air changes per hour (NACH) for a building does not exceed the value given in Table 2.2 when tested in accordance with ASTM E741 "Practice for Measuring Air Leakage Rate by the Tracer Dilution Method" or the National Association of Home Builder's "AIMS" test.

Table 2.2 Airtightness Requirements Natural ACH		
Building Type	Region	NACH
Detached single-family or duplex	1, 2, & 3	0.26
Detached single-family or duplex	4 & 5	0.19
All other	All	0.19

2.4 Fireplaces and Wood Stoves

A fireplace or wood stove shall be installed with the following:

a. A tight-fitting, closeable metal or glass door covering the entire opening of the firebox;

b. A means to utilize outside air for combustion, as per manufacturer's design specifications, and equipped with a readily accessible, operable, and tight-fitting damper;

c. For a fireplace, a tight-fitting flue damper with a readily accessible manual control.

Exception: A gas burning fireplaces shall have a minimum position stop on the damper as specified by the fireplace manufacturer and the appropriate ICBO codes.

2.5 Ventilation Requirements

The airtightness requirements in this Standard substantially reduce air leakage through a building's thermal envelope. This provides the opportunity to introduce controlled ventilation into a building resulting in health, comfort, and energy efficiency benefits. Airtightness, controlled ventilation, and regular maintenance all work hand-in-hand to achieve good indoor air quality. A heat recovery ventilator is not required, but is highly recommended.

Ventilation requirements will be reviewed in two years and modifications made as necessary to improve this Standard.

Ventilation requirements shall be met by using one of the two options listed below and by meeting the requirements of subsection **2.5.3 Mandatory Measures for Ventilation Options I and II** on page 10.

2.5.1 Ventilation Option I. The current ASHRAE (the American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329) Standard 62, "Ventilation for Acceptable Indoor Air Quality" shall be used to determine ventilation requirements for a building.

2.5.2 Ventilation Option II. This ventilation option applies only to a residential building. These requirements deal only with normally encountered levels of household pollutants. Further, this option assumes outdoor air is suitable for ventilation. Specific pollutants and their acceptable levels for adequate indoor air quality are provided in ASHRAE Standard 62. Additionally, the ventilation air called for below does not provide for the combustion or dilution air requirements of a combustion appliance. For Ventilation Option II, all requirements under subsection **2.5.4 Additional Mandatory Measures for Ventilation Option II** on pages 11-12 shall be met.

Ventilation Rate. A ventilation system shall have the capacity to provide ventilation air (air supplied to and exhausted from) the greater of *either*:

a. 0.30 air changes per hour (ACH), based on the volume of conditioned space within a building (this assumes 0.05 ACH is provided by natural air leakage); or

b. The ventilation air rate for a building as determined by using the procedures for Table 2.3.

Table 2.3 Minimum Ventilation Air Requirements, CFM

Space	Base Flow Rate	Exhaust	
		Continuous	Intermittent
Category A Rooms			
Master Bedroom	20		
Other Bedrooms	10		
Living Room	10		
Dining Room	10		
Family Room	10		
Recreation/Hobby Room*	10		
Non-partitioned Basement	20		
Other Habitable Rooms	10		
Category B Rooms			
Kitchen	10	25	100
Bathroom	10	20	50
Laundry Room*	10		
Utility/Work Room* (not mechanical room)	10		

* these rooms may generate excessive indoor air pollutants and may require additional exhaust capability

Procedures for using Table 2.3:

1. Add the base flow cubic feet per minute (cfm) rate for each room in the building.

2. Add the continuous exhaust flow rate for each room in the building.

3. Total ventilation air flow shall be the larger of total base flow cfm or the total continuous exhaust flow cfm. This is the minimum supply and exhaust air that shall be provided.

4. If the total continuous exhaust cfm is larger than the total base flow cfm, then supply air shall be increased to match the exhaust cfm flow rate, or part of the exhaust requirement may be accomplished by intermittent exhaust. If a space chosen for intermittent exhaust is a bathroom or kitchen, the minimum intermittent flow rate listed for the room shall be met. Intermittent exhaust air shall be transported direct to the outdoors. Total continuous ventilation air flow shall still be the larger of the remaining continuous exhaust air flow or the base air flow.

5. The ventilation air requirement for a combined room such as living/dining or kitchen/dining may be determined as if each were an individual room.

6. Ventilation air to a Category B room called for in the base flow rate column can be provided indirectly from a Category A room through continuous exhaust from a Category B room.

7. Ventilation system design shall account for any air flow loss as a result of design specifics or installation effects. A minimum air flow rate specified above shall be verifiable after installation is complete. Caution: Research studies show that low to medium quality ventilation equipment and duct systems generally result in actual air flow rates only 30 to 50 percent of an equipment's rated ventilation capacity. It is recommended that high quality ventilation equipment with a 2.0 sone rating and permanent split capacitor motor be used.

2.5.3 Mandatory Measures For Ventilation Options I And II.

a. Ventilation air through an exterior door or operable window shall not be considered as part of a ventilation system design and shall not be included in proving compliance with a required minimum ventilation rate.

b. Estimated natural ventilation provided by leaks through a building's thermal envelope may be included as part of a ventilation system design. The natural ventilation flow rate, however, shall be confirmed after construction is complete by one of the blower door test methods specified in Section 2.3, Air Tightness. The air flow rate shall be stated in terms of cfm and shall be derived using the Lawrence Berkeley Laboratories (LBL) methodology. A modification of this methodology is not allowed. The test shall be conducted by a person trained and certificated by the Alaska Craftsman Home Program to do such work. The accuracy of airflow measurement for blower door equipment shall be accurate within ± 10 percent of the actual measured flow rate. Pressure measurement apparatus shall be accurate to within ± 2 pascals.

If the tested natural ventilation rate is less than estimated during design, the ventilation system shall be upgraded so that the total minimum ventilation air requirement is met.

2.5.4 Additional Mandatory Measures For Ventilation Option II.

a. If using a central ventilating appliance, the supply and exhaust air flows shall be balanced within 10 percent of each other. A means to permanently assure flow rates within the balancing tolerance shall be provided.

b. A ventilation system shall be designed and installed to uniformly mix and circulate supply air throughout an occupied zone. Supply air shall be introduced into a room in a manner that does not create human discomfort and is not potentially damaging to the building.

c. There shall be adequate air circulation into and out of a room at all times. A door or transom louver, undercut door, wall transfer fan, return grille or other means shall be used.

d. Exhaust air for a residential building shall not be recirculated except that cross-flow leakage from the exhaust to the supply air stream of a heat recovery ventilator (HRV, formerly referred to as air-to-air-heat exchanger) shall be limited to no more than 5 percent.

e. A backdraft or automatic damper shall be used to provide positive closure of a dedicated exhaust duct during a standby period.

f. A clothes dryer or kitchen range hood exhaust duct shall lead directly to the outdoors and shall not be connected to a ventilation system.

g. A ventilation system's supply and exhaust vents on the exterior of a building shall be separated a minimum of 6 feet horizontally and shall be at least 18 inches above an adjacent finished grade. A vent location shall also be placed a minimum of 10 feet horizontally away from a known pollutant source (such as car exhaust fumes). Care shall be taken to locate a vent where the effect of wind or snow accumulation does not adversely affect the ventilation system's performance. Coordinate location requirements with the appropriate ICBO codes and local site conditions.

h. An exterior exhaust vent shall not be located where the exhaust air rises into an attic vent.

i. A duct transporting ventilation air shall be sealed at all joints. Wrapping with duct tape alone is not adequate. A duct transporting ventilation air of 60°F or greater through any unconditioned space shall be insulated to a minimum of R-6 and wrapped with a vapor retarder of 0.06 perms or less.

j. A ventilation air duct shall use a smooth-walled material such as galvanized steel or lined fiberglass (rigid or semi-rigid) as much as possible. When necessary to use flexible ducting, it shall be supported along its full length with no sags and no bends greater than 90 degrees.

k. A mechanical ventilation appliance shall be equipped with one or more automatic controls. Some examples are a timer, dehumidistat, or sensor. A control shall also have a manual override option.

l. A ventilation system may be designed to shut completely off during daily periods when a building is not occupied, but shall not exceed more than 12 hours per day. A manual shutoff capability shall be provided for extended periods of non-occupancy such as vacations.

m. Where the operation of a ventilation system includes a period when no supply air is provided (such as defrost cycles for heat recovery ventilators), the system shall be designed so that the total time of no supply air does not exceed one hour within any two hour period.

n. A builder shall provide written operation and maintenance instructions to a homeowner for the ventilation system.

o. A combustion appliance such as a furnace, boiler, wood stove, or fireplace shall be provided with sufficient combustion and venting air as required by the appliance manufacturer. This requirement is in addition to ventilation air requirements given above.

p. A ventilation appliance shall not be located in a space that is difficult or inconvenient to access such as a crawl space or attic if the appliance requires maintenance on a monthly or more frequent basis.

2.5.5 Air Pressure Limitations. Controlling interior air pressures within acceptable positive and negative tolerances is critical to occupant safety, building longevity and building performance. Positive pressure can force moist indoor air into the thermal envelope. This moisture can condense, freeze, and build up over the winter. Ice buildup degrades insulation performance, encourages mold and mildew growth, and ice expansion damages the building. Thawing during the summer causes water damage and wood rot. This damage often goes unchecked for several years because it occurs mostly within the thermal envelope, out of sight. Negative pressure can cause backdrafting of heating and cooking appliances. Backdraft exhaust fumes contain a number of gases dangerous to human health such as carbon monoxide and nitrogen oxides. Carbon monoxide causes headaches, drowsiness, shortness of breath, blurred vision, and dizziness. High concentrations lead to death. Nitric oxide produces toxic effects similar to carbon monoxide and additionally irritates the eyes, nose, and throat. Nitrogen dioxide causes lung damage.

For these reasons, it is highly recommended that the considerations in Appendix C, Air Pressure Limitations be followed.

2.6 Windows, Doors, and Skylights

Windows, doors, and skylights affect heat loss more than any other element of a building's thermal envelope. For example, windows can account for as much as 25 percent of the total envelope conductive heat loss although they generally account for only 3 to 5 percent of the total envelope area. A common double-glazed window loses 10 times more heat per square foot than a 2x6 insulated wall.

Window, door, and skylight requirements will be reviewed in two years and modifications will be made as necessary to improve this standard. The following requirements apply to a window, door, or skylight:

a. A product performance claim referencing a test conducted after December 31, 1994 shall be acceptable only if testing was performed using the protocols specified by the National Fenestration Rating Council (NFRC, 962 Wayne Avenue, Suite 750, Silver Springs, MD 20910). Such a test shall be conducted by an independent laboratory certified by NFRC to perform such a test. The test report shall include a statement that the test was performed in accordance with NFRC protocols.

   A product performance claim referencing a test conducted under the AAMA 1503.1-80, AAMA 1503.1-88, ASTM C236-80, or ASTM C236-87 test method prior to January 1, 1995 shall be acceptable. Thereafter, only a performance test conducted under the NFRC protocols shall be acceptable. In addition, the following restrictions apply to the AAMA test methods.

   1. Standard test size for residential windows shall be:

Window Type	Width by Height (inches)
Horizontal sliding	60 by 36
All Other	36 by 48

   2. A window test sample shall be of a production line size closest to the model size stated above.

b. A sample used for testing shall be a production line unit or representative of a unit commonly manufactured. No adjustment shall be made to a unit to prepare it for testing than would ordinarily be made in the field by a builder.

c. A laboratory test report showing all relevant product performance values shall be submitted to the Energy Resource Information Center, 949 E. 36th Avenue, Suite 400, Anchorage, AK 99508. A manufacturer's literature is NOT an acceptable substitution for a laboratory test report. A report will be available for public inspection to allow consumers to verify performance claims.

d. A hollow core wood door or a single-glazed window or skylight in the thermal envelope is not allowed regardless of which method (chapter 3, 4, 5, or 6) is used to comply with this Standard.

e. A metal frame for a window, skylight, or threshold shall have a continuous thermal break between inside and outside metal surfaces.

f. A window, door, or skylight whose performance is not documented by a test report shall be given a default R-value as follows:

Product	Default R-Value
double-glazed window or skylight	1.7
triple-glazed window or skylight	2.5
insulated metal door	5
solid core wood door	2.5
door with glazing	1.7

g. Air infiltration shall be limited to the following maximums:

1. *Operable Window:*

   casement: 0.10 cubic feet per minute per linear foot of operable sash crack;
   awning/projecting: 0.15 cubic feet per minute per linear foot of operable sash crack;
   sliding/double hung: 0.20 cubic feet per minute per linear foot of operable sash crack;
   fixed: 0.10 cubic feet per minute per square foot of window;
   all other: 0.15 cubic feet per minute per linear foot of operable sash crack;

2. *Swinging Door:* 0.10 cubic feet per minute per linear foot of door perimeter;

3. *Sliding Door:* 0.05 cubic feet per minute per square foot of door.

2.7 Crawl Space Vents

A crawl space vent shall be equipped with a mechanism allowing tight closure when necessary.

Exception: Combustion air shall be provided at all times to an appliance which draws crawl space air for combustion.

2.8 Permeability of Outer Envelope Surfaces

Water vapor penetrating through a vapor retarder must be able to pass on through a building's thermal envelope material to the outdoors. Water vapor that does not pass through to the outdoors condenses into liquid water, then ice, when temperatures within the assembly are cold enough. Temperatures as high as 42°F may be enough to begin condensation. Continued conditions like this can damage insulation and a building's structure.

Permeability of building materials on the exterior side of a vapor retarder determine how easily vapor within a thermal envelope assembly migrates to the outdoors. These materials shall therefore have a dry cup perm rating of 5 or more.

Exception: A panelized foam core building product, insulation board product such as urethane, polyisocyanurate, or expanded polystyrene, or plywood siding product is exempted. If using an insulation board product, do not tape joints between boards.

2.9 Attached Garages

A wall, ceiling, or floor of conditioned space adjoining a garage shall have insulation and a vapor retarder installed in the same manner as required for other thermal envelope assemblies. For this purpose, a garage shall be considered an unconditioned space.

2.10 Conservation of Hot Water

Hot water is usually the second most demanding use of energy in a residential building. In a highly insulated residential building, hot water can be *the* most demanding use of energy. Efficient use of hot water, therefore, can lower a building's energy costs significantly.

The following mandatory measures are required:

a. A showerhead shall be equipped with a flow control device that limits water flow to a maximum of 2.5 gallons per minute.

   Exception: A flow control device is not required where water turbidity or the distribution pressure at an outlet may render it unusable.

b. A toilet shall be plumbed to use the least amount of heated water necessary to prevent condensation on the tank or bowl. Alternatively, an insulated toilet tank may be used to prevent condensation.

c. A domestic hot water tank installed in an unconditioned space shall have the tank top and side surfaces insulated to at least R-16 for an electric water heater or storage tank or R-10 for a fuel burning water heater or storage tank. Insulation may be an integral part of or wrapped around the outside of a water heater or storage tank. In no case shall the combined internal and external insulation total be less than required. Externally wrapped insulation shall not cover the control panel nor interfere with a relief or drain valve, drain pipe, incoming or outgoing plumbing line, or air flow requirement. Clearance to a flue gas vent shall be as specified in the appropriate ICBO code.

   Exception: A water heater with no storage tank is exempt from the above insulation requirements.

d. A hot-water pipe coming out of a water heater shall be insulated with at least R-4 insulation for the first 3 feet of pipe closest to the water heater. It is not necessary, however, to penetrate a wall or ceiling with the pipe insulation to maintain the 3 foot requirement. Check ICBO codes for required clearances to a flue gas vent.

e. To minimize conductive heat loss, an electric water heater shall not be placed in direct contact with a concrete floor. A platform shall be constructed to provide a minimum clearance of 10 inches from the concrete floor to the bottom of the heater, or R-10 insulation between the floor and the bottom of the heater shall be installed.

f. A water heater shall have a thermostat capable of varying the heater's temperature setting. At time of installation, a thermostat shall be set to 120°F. A builder shall instruct the building owner about the ability to vary the temperature setting.

g. A water heater shall be equipped with a heat trap, check valve, or other mechanism on both inlet and outlet pipes to prevent convective water movement.

2.11 Plumbing

A hydronic or domestic hot-water pipe located outside of a conditioned space and not intentionally used to heat the space or, if within 3 inches of a cold-water pipe, shall be insulated to a minimum R-4.0.

2.12 Heating Air Ducts

A heating air duct shall be sealed against air leakage at all joints and seams by using caulking, sealant or other appropriate material. Wrapping with duct tape alone is not adequate. A duct transporting air of 60°F or more through an unconditioned space shall be insulated to a minimum R-6 and wrapped with a vapor retarder of 0.06 or less perm rating.

2.13 Heating Systems

Poorly or improperly functioning heating equipment can easily increase heating costs by 25 percent. Savings gained from better equipment, properly installed and maintained for maximum efficiency can more than offset the extra cost of that equipment.

The following requirements govern a heating system:

a. A heating appliance shall be installed, tested, and adjusted per the manufacturer's recommendations prior to being turned over to a homeowner.

b. Adequate combustion air shall be provided to an appliance for proper operation at all times.

c. A chimney or exhaust gas vent system shall be installed per the manufacturer's recommendations for proper operation, maintenance, and safety to eliminate condensation or backdrafting problems.

d. A heating appliance and its related components shall meet or exceed the manufacturer's federal requirements for energy-efficiency performance current at time of installation.

CHAPTER 3

PRESCRIPTIVE METHOD

This chapter establishes minimum thermal envelope insulation requirements for buildings. Exceeding these minimums is encouraged.

The Prescriptive Method does not require extensive calculations. It is the least flexible of the four possible compliance methods. This method shall not be used to trade-off an R-value requirement between a different thermal envelope assembly or different element of the same assembly. For example, more insulation in the ceiling does not decrease the required insulation in the wall. If this is desired, Chapter 4, 5 or 6 shall be used as the means of compliance.

The Prescriptive Method does not dictate specific building methods or materials. Any method of constructing a building may be used provided clear compliance with the minimum insulation requirements is shown. For example, to meet a minimum R-18 wall insulation requirement, R-19 fiberglass batt in a 2x6 framed wall may be used, or R-13 fiberglass batt in a 2x4 framed wall with R-5 rigid insulation over the framing, or R-18 urethane foamed-in-place between 2x4 framing.

When using the Prescriptive Method as the means of compliance, all mandatory measures given in Chapter 2 shall also be accomplished.

3.1 Insulation Minimums

R-value minimums given in this chapter are for insulation installed between or over structural members. Only the insulation R-value is counted. R-value for an air film or a material such as sheetrock, paneling, plywood, siding, or earth backfill, for example, shall not be included.

R-value minimums refer to the *installed* R-value. Compression of some insulating products results in a lower R-value. For example, placing a standard R-30 batt into a 2x8 wall compresses the batt from 9 inches down to 7¼ inches. This results in a decreased R-value from the listed R-30 down to approximately R-26. Table 3.1 (see top of next page) shows nominal examples of resultant R-values when fiberglass batts are compressed.

3.2 Ceilings

a. A thermal envelope ceiling shall be insulated to the minimum R-value shown in Table 3.2.

3.3 Above-Grade Walls

a. An above-grade thermal envelope wall shall be insulated to the minimum R-value shown in Table 3.2. This includes the floor rim joist area.

TABLE 3.1

Example of resultant R-values when fiberglass batt insulation is compressed into a confined space such as in wall stud or floor joist spaces. Product thickness and density differ among manufacturers and therefore resultant R-values also differ slightly.

Nominal Lumber Size	Actual Width	Initial R-value and thickness					
		R-38 12"	R-30 9 1/2"	R-22 6 3/4"	R-19 6 1/8"	R-13 3 5/8"	R-11 3 1/2"
		Installed R-value at final thickness					
2" x 12"	11¼"	37					
2" x 10"	9¼"	32	30				
2" x 8"	7¼"	27	26				
2" x 6"	5½"		21	20	18		
2" x 4"	3½"		14	13	13		
2" x 3"	2½"					10	9
2" x 2"	1½"					6	6

3.4 Below-Grade Walls (Foundation Walls)

a. A below-grade thermal envelope wall shall be insulated to the minimum R-value shown in Table 3.2.

b. A required R-value for crawl space wall insulation shall be maintained for the full height of the wall.

c. A required R-value for basement wall insulation shall be maintained for the upper most four feet of the wall. The remaining length of wall shall maintain at least one-half the required R-value.

d. Exterior insulation may extend in a horizontal or diagonal manner out from a wall provided the length of insulation meets or exceeds that which would be placed in a vertical manner.

e. An insulation material shall have appropriate weather resistant properties for the intended use and shall be applied as recommended by the insulation manufacturer.

3.5 Floors

a. A thermal envelope floor shall be insulated to the minimum R-value shown in Table 3.2.

b. A rim joist area of a thermal envelope floor shall be insulated to the same requirement as given for an envelope floor.

c. A rim joist area of a non-thermal envelope floor (such as where a crawl space wall is insulated but the floor is not, or a second story floor) shall be insulated to the same requirement as given for an Above-Grade or Below-Grade envelope wall, as appropriate.

3.6 Slab-on-grade Floors

a. A concrete slab-on-grade floor of a conditioned space or enclosed semiconditioned space shall be insulated to the minimum R-value shown in Table 3.2.

b. An insulation material shall have appropriate weather-resistant properties for below-grade application and shall be applied as recommended by the manufacturer. Insulation damaged during construction shall be replaced.

c. Insulation for a thickened edge or grade beam concrete slab floor shall extend downward from the top of the slab to the bottom of the footing, then horizontally beneath the footing for its full width. Alternatively, insulation may extend downward from the top of the slab to the bottom of the footing, then diagonally out from the footing for a minimum horizontal distance of 18 inches.

d. Horizontally placed insulation under the perimeter of a basement concrete slab floor shall be continuous around the entire perimeter of the slab and shall be a minimum of 24 inches wide. Additionally, a thermal break shall be provided between the foundation wall and the slab edge.

e. Permafrost areas require engineering analysis for proper application of insulation in contact with the ground. Improper application can result in ground thawing and cause severe damage to the structure.

3.7 Windows and Sliding Glass Doors

a. An exterior window R_o-value (overall R-value, including the frame) shall not be less than specified in Table 3.2.

b. A sliding glass door shall be considered a window for the purpose of determining total allowable glazed area percentage (see paragraph c below) and required R-value. A window or sliding glass door shall also comply with mandatory requirements stated in Chapter 2, Section 2.6.

c. Total window and sliding glass door area shall not exceed 15 percent of the total gross above-grade thermal envelope wall area. If more than 15 percent window area is desired, Chapter 4, 5, or 6 shall be used as the method of showing compliance with the overall energy efficiency of a building.

d. A window for special architectural or decorative purpose may have an R-value less than required by Table 3.2 provided:

1. it is double glazed or more, and

2. total decorative window area does not exceed 5 percent of the allowable window area specified in paragraph c up to a maximum of 16 square feet.

3.8 Skylights

a. A skylight shall have a minimum R_o-value of 2.5 (U_o-value of 0.4).

b. Skylight area shall not exceed 1 percent of the total ceiling thermal envelope area.

c. A skylight sidewall that is not an integral part of the skylight product shall be insulated to the same R-value as the ceiling.

d. A skylight shall also conform to the requirements stated in Chapter 2, Paragraph 2.6.

3.9 Doors

a. An exterior door R_o-value shall not be less than specified in Table 3.2.

b. Door glazing shall be minimum double glazed with a one-half inch minimum air space.

c. An exterior door shall also conform to the requirements stated in Chapter 2, Paragraph 2.6.

d. A sliding glass door, shall be considered as a window for the purpose of determining R-value and area requirements. See Section 3.7 above.

3.10 Log House

If a wall of a log house does not meet the prescriptive insulation value of Table 3.2, the house shall comply with this Standard by use of Chapter 4 or 5.

TABLE 3.2 Thermal Envelope R-value Requirements

This table lists minimum thermal envelope insulation requirements for buildings. Any method of constructing a building's thermal envelope may be used provided clear compliance with the listed R-values is shown and is acceptable to approving officials. R-value minimums refer to the installed R-value which may be different from the listed product R-value. Higher R-values may be used if desired.

CAUTION: Permafrost areas require engineering analysis for proper application of insulation in contact with the ground.

Region Number	Region Name	Heating Fuel	Thermal Envelope R-Value Requirements							
			Ceiling	Above grade Wall	Floor	Below grade Wall	Slab Floor		Window	Door[1]
							Base-ment	On Grade		
1	Southeast	All Fuels	38	21	30	15	10	15	3.0	2.5, 7
2	Southcentral	Natural Gas	38	18	19	10	10	10	3.0	2.5, 7
2	Southcentral, Aleutian, Kodiak	All Fuels other than natural gas	38	25	30	15	10	15	3.0	2.5, 7
3	Interior, Southwest	All Fuels	38	25	38	19	10	15	3.0	7
4	Northwest	All Fuels	38	30	38	19	10	15	3.0	7
5	Arctic Slope	All Fuels	52	35	43	--	--	--	3.0	7

Note:

1. Not more than one exterior door in a residential building in Region 1 or 2 may have an R-value less than 7, but not less than 2.5.

CHAPTER 4

PERFORMANCE METHOD

The Performance Method allows a trade-off of insulation requirements between elements of a particular thermal envelope assembly. For example, if window area above the allowed 15 percent maximum (as given in Chapter 3) is desired, the Performance Method allows such an increase provided the opaque wall R-value is also increased. Compliance is met when the opaque wall R-value increases enough to offset the extra heat loss resulting from the increased window area.

A trade-off between different thermal envelope assemblies is not allowed under this method. In other words, more insulation in the ceiling does not allow for decreased insulation in the wall. For this kind of trade-off, Chapter 5, Building Budget Method, or Chapter 6, Energy Rating Method shall be used.

The Performance Method may be used together with the Prescriptive Method. For example, if the ceiling and floor meet compliance to this Standard through the Prescriptive Method, but the wall does not, compliance for the wall may be met through the Performance Method which allows for R-value trade-offs between wall elements.

The Performance Method requires some calculations. R-value for an air film or a material such as sheetrock, paneling, plywood, or siding, for example, may be included when calculating the overall transmittance value (U_o-value) of an assembly. Insulation value for earth backfill, however, shall not be included. A workbook is available to help with these calculations.

When using the Performance Method, all mandatory measures given in Chapter 2 shall also be accomplished.

Design and insulation requirements are given below and also shown in Table 4.1.

Calculations used to determine compliance with the U_o-values shown in Table 4.1 shall be submitted to State officials for verification.

4.1 Relationship of U-values and R-values

To convert R-value to U-value, divide 1 by the R-value. For example, to convert R-38 to U-value: 1 ÷ 38 = 0.026. To convert U-value to R-value, divide 1 by U-value. For example, to convert U-0.026 to R-value: 1 ÷ 0.026 = 38. An example of how to calculate an overall thermal transmittance value (U_o) is given in Appendix B.

When R-values are converted to U-values, at least the first three decimal places shall be used. Do not round the third digit. For example, the U-value of R-19 insulation carried to four decimal places is: U = 1/19 = 0.0526. Use U = 0.052 or U = 0.0526. Do not round to U = 0.053.

4.2 Overall U_o-Values

The stated U-value of any one element of an envelope assembly may be increased while another element is decreased, provided the overall U_o-value of the entire assembly does not increase. Equations 1, 2, and 3 shall be used to determine U_o.

4.3 Ceilings

a. Overall thermal transmittance value (U_o) for gross ceiling thermal envelope area shall not exceed the value shown in Table 4.1 for ceiling.

b. Equation 1 shall be used to determine acceptable combinations to meet the required ceiling U_o-value.

$$U_o\text{ceiling} = \frac{(U_{ceiling} \times A_{ceiling}) + (U_{skylight} \times A_{skylight})}{A_o}$$ *Equation 1*

Where:

$U_o$ceiling	=	the overall thermal transmittance value of the gross ceiling thermal envelope area expressed as Btu/ft^2•hr•°F
A_o	=	the gross overall ceiling thermal envelope area in ft^2
$U_{ceiling}$	=	the composite thermal transmittance of all elements of the opaque ceiling expressed as Btu/ft^2•hr•°F
$A_{ceiling}$	=	the gross opaque ceiling thermal envelope area in ft^2
$U_{skylight}$	=	the composite thermal transmittance of all elements of the skylight, including the frame, expressed as Btu/ft^2•hr•°F
$A_{skylight}$	=	the area of the skylight(s), including the frame, in ft^2

c. Where more than one type of envelope ceiling and/or skylight is used, the U x A term for that exposure shall be expanded into its subelements, as:

$$U_o\text{ceiling} = \frac{(U_{ceiling\ 1} \times A_{ceiling\ 1}) + (U_{ceiling\ 2} \times A_{ceiling\ 2}) + \ldots\text{, etc.}}{A_o}$$ *Equation 1.1*

4.4 Walls

a. *Above-grade Wall:* Overall thermal transmittance value (U_o) for gross above-grade thermal envelope wall area shall not exceed the value shown in Table 4.1 for above-grade wall.

b. *Below-grade Wall:* Overall thermal transmittance value (U_o) for gross below-grade thermal envelope wall area shall not exceed the value shown in Table 4.1 for below-grade wall.

1. Required U_o-value for crawl space wall insulation shall be maintained for the full height of the wall.

2. Required U_o-value for basement wall insulation shall be maintained for the upper

most four feet of the wall. The remaining length of wall shall maintain one-half or more the required insulation value.

c. An insulation material shall have appropriate weather-resistant properties for the intended use and shall be applied as recommended by the insulation manufacturer.

d. U-value for earth backfill shall not be included when calculating U_o for a below-grade wall.

e. Equation 2 shall be used to determine acceptable combinations to meet the required wall U_o-value. Above-grade walls and below-grade walls are calculated as separate envelope assemblies.

$$U_o wall = \frac{(U_{wall} \times A_{wall}) + (U_{window} \times A_{window}) + (U_{door} \times A_{door})}{A_o}$$

Equation 2

Where:

$U_o wall$ = the overall thermal transmittance value of the gross wall thermal envelope area expressed as $Btu/ft^2 \bullet hr \bullet {}^oF$

A_o = the gross overall wall (above or below grade wall, as appropriate) thermal envelope area in ft^2

U_{wall} = the composite thermal transmittance of all elements of the opaque wall expressed as $Btu/ft^2 \bullet hr \bullet {}^oF$

A_{wall} = the gross opaque wall thermal envelope (above or below grade wall, as appropriate) area in ft^2

U_{window} = the composite thermal transmittance of all elements of the window area, including the framing and sash expressed as $Btu/ft^2 \bullet hr \bullet {}^oF$

A_{window} = the area of the window(s), including the framing and sash, in ft^2

U_{door} = the composite thermal transmittance of all elements of the door expressed as $Btu/ft^2 \bullet hr \bullet {}^oF$

A_{door} = the area of the door(s) in ft^2

f. Where more than one type of envelope wall, window, or door is used, the U x A term for that exposure shall be expanded into its subelements, as:

$$U_o ceiling = \frac{(U_{wall\ 1} \times A_{wall\ 1}) + (U_{wall\ 2} \times A_{wall\ 2}) + ..., etc.}{A_o}$$

Equation 2.1

4.5 Floors

a. Overall thermal transmittance value (U_o) for gross thermal envelope floor area shall not exceed the value shown in Table 4.1 for floor.

b. A rim joist area of a thermal envelope floor shall be insulated to the same requirement as given for an envelope floor.

c. A rim joist area for a non-thermal envelope floor shall be insulated to the same requirement as given for an Above-Grade or Below-Grade envelope wall, as appropriate.

d. Equation 3 shall be used to determine an acceptable combination to meet the required floor U_o-value.

$$U_o floor = \frac{(U_{floor} \times A_{floor})}{A_o}$$

Equation 3

Where:

$U_o$floor = the overall thermal transmittance value of the gross floor thermal envelope area expressed as Btu/ft^2•hr•°F

A_o = the gross overall floor thermal envelope area in ft^2

U_{floor} = the composite thermal transmittance of all elements of the opaque floor expressed as Btu/ft^2•hr•°F

A_{floor} = the gross opaque floor thermal envelope area in ft^2

Where more than one type of envelope floor is used, the U x A term for that exposure shall be expanded into its subelements, as:

$$U_o floor = \frac{(U_{floor1} \times A_{floor1}) + (U_{floor2} \times A_{floor2}) + \ldots, \text{etc.}}{A_o}$$

Equation 3.1

4.6 Slab-on-grade Floors

a. Overall thermal transmittance value (U_o) for a concrete slab floor of a conditioned space or enclosed semiconditioned space shall not exceed the value shown in Table 4.1 for slab-on-grade floor.

b. Insulation material shall have appropriate weather-resistant properties for below-grade application and shall be applied as recommended by the manufacturer. Insulation damaged during construction shall be replaced.

c. Insulation for a thickened edge or grade beam concrete slab floor shall extend downward from the top of the slab to the bottom of the footing, then horizontally beneath the footing for its full width. Alternatively, insulation may extend downward from the top of the slab to the bottom of the footing, then diagonally out from the footing for a minimum horizontal distance of 18 inches.

d. Horizontally placed insulation under the perimeter of a basement concrete slab floor shall be continuous around the entire perimeter of the slab and shall be a minimum of 24 inches wide. Additionally, a thermal break shall be provided between the foundation wall and the slab edge.

f. A permafrost area requires engineering analysis for proper application of insulation in contact with the ground. Improper application can result in ground thawing and cause severe damage to the structure.

4.7 Framing Factors

a. The following factors may be used for a wood framed wall, ceiling, or floor when calculating the overall U-value required in this chapter. A framing factor accounts for the estimated amount of wood framing contained in an opaque thermal envelope area.

Ceiling or Floor:
- 18 percent for 2-inch joists at 12 inches on center
- 10 percent for 2-inch joists at 16 inches on center
- 6 percent for 2-inch joists at 24 inches on center
- 10 percent for 2-inch plank and 4-inch beams at 48 inches on center

Wall:
- 15 percent for 2-inch studs at 16 inches on center
- 12 percent for 2-inch studs at 24 inches on center

b. Alternatively, a framing factor may be ignored, provided only an insulation R-value is counted. An R-value for an air film or other materials (such as exterior siding or interior finish) shall be ignored along with framing factors.

TABLE 4.1 Maximum Allowable Envelope U_o-values

Caution: A permafrost area requires engineering analysis for proper application of insulation in contact with the ground.

Region Number	Region Name	Heating Fuel	Envelope Performance Criteria, U_o					
			Ceiling	Above grade Wall	Floor	Below grade Wall	Slab Floor	
							Base-ment	On grade
1	Southeast	All Fuels	0.024	0.089	0.032	0.066	0.100	0.066
2	Southcentral	Natural Gas	0.024	0.099	0.046	0.100	0.100	0.100
2	Southcentral, Aleutian, Kodiak	All Fuels other than natural gas	0.024	0.085	0.032	0.066	0.100	0.066
3	Interior, Southwest	All Fuels	0.024	0.078	0.028	0.059	0.100	0.066
4	Northwest	All Fuels	0.024	0.073	0.028	0.059	0.100	0.066
5	Arctic Slope	All Fuels	0.018	0.069	0.022	--	--	--

CHAPTER 5

BUILDING BUDGET METHOD

This chapter sets limits on the total amount of space heating energy used by a building. The Building Budget Method requires a HOT-2000 computer energy use analysis or manual calculations in a format similar to that shown in the Building Energy Efficiency Standard Workbook.

5.1 Submission Requirements

Documents used to determine compliance with the building budget values shown in Table 5.1 shall be submitted to State officials for verification. These may include, but are not limited to: plans and specifications showing details of all pertinent data, features, equipment, and systems of a building including complete descriptions of materials, engineering data, test data, manufacturer's data, and all other data necessary to allow proper identification of components that affect a building's energy use. Submissions lacking sufficient detail to verify a building's energy budget may be rejected.

5.2 Compliance

a. A building designed in accordance with this option shall not exceed the Btu budget given in Table 5.1 expressed in Btu per square foot of floor area of conditioned space per year. Compliance shall be verified by a hard copy printout of a HOT-2000 analysis or copies of manual calculations. Copies of the HOT-2000 computer program may be obtained from:

   Alaska Craftsman Home Program, Inc.
   P.O. Box 876130
   Wasilla, AK 99687
   Telephone (907) 373-2247

b. A heat recovery ventilator (air-to-air heat exchanger) included in the design of a building can lower the building's heat loss. This energy savings, in Btu's, may be used to trade off (lower) a thermal envelope insulation requirement while still meeting the maximum heat loss budget given in Table 5.1. However, no thermal envelope assembly, such as a ceiling, skylight, wall, window, door, or floor shall have an R-value level lower than 80 percent of that given in Chapter 3, Table 3.2, Prescriptive Envelope R-value Requirements, except a log wall (not a window or a door) is exempt from this requirement.

c. A heat loss maximum shall be verified by dividing the Gross Space Heating Load, as listed in the HOT-2000 printout under Annual Space Heating Summary, by a building's total conditioned space floor area.

d. When using the Building Budget Method, all mandatory measures given in Chapter 2 shall also be accomplished.

5.3 Design Parameters

The following design parameters shall be used in conjunction with the HOT-2000 computer energy use program:

a. Indoor design dry bulb temperature shall be set no lower than 70°F for space heating;

b. Select heating degree days, outdoor design dry bulb temperature, solar gains, internal gains, and other data inputs from the HOT-2000 data base menu and other sources that most closely approximate the long term conditions expected for the structure or site.

TABLE 5.1 Maximum Allowable Heat Loss
(BTU/ft^2 of floor area/year)[1]

These Heat Loss maximums are for space heating only.

Region Number	Region Name	Heating Fuel	Detached Single-family Building	Multi-family and Community Building
1	Southeast	All Fuels: crawl space[2]	28,750	11,900
		exposed floor[3]	21,600	9,500
		basement[4]	21,000	11,700
2	Southcentral	Natural Gas: crawl space[2]	42,050	20,000
		exposed floor[3]	34,500	17,800
		basement[4]	30,400	18,000
2	Southcentral, Aleutian, Kodiak	All Fuels other than natural gas: crawl space[2]	36,000	15,700
		exposed floor[3]	27,600	12,800
		basement[4]	25,800	14,900
3	Interior, Southwest	All Fuels: crawl space[2]	67,650	33,300
		exposed floor[3]	39,050	22,200
		basement[4]	35,200	23,300
4	Northwest	All Fuels	43,100	26,400
5	Arctic Slope	All Fuels	57,100	38,100

NOTES:
1. The gross floor area of all conditioned spaces and including a basement.
2. Where a crawl space wall is insulated rather than the floor and a crawl space is heated indirectly by heat loss through a floor.
3. Where a floor is insulated and the crawl space is unheated.
4. Basement wall insulated down to the footing.

CHAPTER 6

ENERGY RATED HOMES METHOD

Compliance with this Standard for a residential building may be shown through a rating from the Energy Rated Homes of Alaska program.

6.1 Rating Requirements

a. A building shall achieve at least a Four Star rating on the Energy Rated Homes of Alaska rating sheet. On January 1, 1995 the requirement shall be increased to Four Star Plus.

b. A structure shall achieve a level C, D, or E air tightness rating on an Energy Rated Homes of Alaska rating sheet.

c. Only a person trained and certificated by the Energy Rated Homes of Alaska program shall submit a rating for compliance. A copy of the Energy Rated Homes of Alaska energy rating shall be provided to State officials. A list of persons certificated by Energy Rated Homes of Alaska may be obtained from:

   State of Alaska
   Department of Community and Regional Affairs
   Energy Programs
   949 E. 36th Avenue, Suite 400
   Anchorage, AK 99508
   (907) 563-1073

d. A building shall comply with ventilation requirements in Chapter 2 of this Standard. A rater shall specify which of the two ventilation options was used.

CHAPTER 7
DEFINITIONS

1. **Above-grade Wall** is any portion of a thermal envelope wall more than 12 inches above an adjacent finished grade.

2. **Air Infiltration** is an uncontrolled flow of air through a hole, opening, crack or crevice in a thermal envelope caused by pressure effects of wind and/or the effect of differences in indoor and outdoor air density.

3. **Approved** is approval by a State or building official of a material or type of construction as the result of an investigation or test by them, or by reason of an accepted principle or test by a recognized authority or technical or scientific organization.

4. **Below-grade Wall** is any portion of a wall which extends no more than 12 inches above an adjacent finished grade.

5. **British Thermal Unit (Btu)** is the approximate amount of heat energy required to raise the temperature of one pound of water by one degree Fahrenheit.

6. **Ceiling** is a group of members which define the boundaries of a space and has a slope of 60 degrees or less from the horizontal plane.

7. **Conditioned Space** is a room or other enclosed space which is intentionally or unintentionally heated to a temperature of 50 degrees Fahrenheit or higher. A bedroom, living room, or kitchen is an example of a conditioned space.

8. **Door Area** is an opening (other than a window) in a wall, including the framing and sash, used by people to enter and exit a building.

9. **Dry-bulb temperature** is the temperature of air as indicated by a standard thermometer, as contrasted with wet bulb temperature which depends upon atmospheric humidity.

10. **Energy Rated Homes of Alaska** is a national program developed by Energy Rated Homes of America and adapted for use in Alaska. The program is a public/private partnership between the Alaska Department of Community and Regional Affairs and the Alaska State Homebuilders Association. Energy Rated Homes of Alaska uses trained persons to survey and rate residential buildings for their energy efficiency. There are ten rating levels -- from a low of One Star to the highest at Five Star Plus.

11. **Glazing** is a transparent or translucent material in an exterior envelope that lets in natural light, including a window, skylight, sliding glass door, glass brick wall, or the glazed portion of a door.

12. **Gross Ceiling Thermal Envelope Area** is the sum of all ceiling thermal envelope areas including the area directly above exterior walls.

13. **Gross Floor Thermal Envelope Area** is the sum of all floor thermal envelope areas including a basement, mezzanine, or intermediate floored tier of headroom height,

measured from the exterior face of an envelope wall or from the center line of a wall separating a building, but not including:

° A covered walkway, open roofed-over area, porch, or similar space;

° An exterior terrace, step, chimney, roof overhang, or similar feature.

14. **Gross Wall Thermal Envelope Area** is the sum of all wall thermal envelope areas including opaque wall areas, window areas, and door areas and measured from the subfloor elevation for an above-grade wall or from the top of the footing for a below-grade wall up to the junction point with a roof/ceiling structural member.

15. **Heating Degree Days (HDD65)** is a unit, based upon temperature difference and time, used in estimating fuel consumption and specifying the nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65 degrees Fahrenheit, there are as many Heating Degree Days as degrees Fahrenheit difference in temperature between the mean temperature for the day and 65 degrees Fahrenheit.

16. **HOT-2000** is a computer-based energy use analysis program developed by Canada for use in the R-2000 building program.

17. **Opaque Thermal Envelope Area** is all thermal envelope areas except openings for glazed area (windows, skylights, or sliding glass doors) or door area.

18. **R-value** is a measure of the ability of a given material to resist heat flow. R is the numerical reciprocal of U. Thus, $R = 1/U$. The higher the R, the higher the insulating value. All insulation products having the same R, regardless of material thickness, are equal in insulating value; expressed as ft•hr•°F/Btu. R-values for individual elements can be added to give a total R-value for an assembly.

19. **R_o-value** is a measure of the overall ability of a gross area to resist heat flow. Heat may flow through various materials along various parallel paths. R_o is the numerical reciprocal of U_o. Thus, $R_o = 1/U_o$; expressed as ft•hr•°F/Btu.

20. **Semiconditioned Space** is a room or other enclosed space which is heated directly or indirectly by the presence of a component of a heating system or by thermal transmission from an adjoining conditioned space. A crawl space, attached garage, mechanical room, or basement is an example of a semiconditioned space.

21. **Skylight Area** is an opening in a roof surface which is glazed with a transparent or translucent material, including the frame.

22. **Slab-on-grade** is horizontally placed concrete in direct or indirect (as when placed over rigid insulation) contact with the ground and used as a thermal envelope floor.

23. **Thermal Envelope** is an assembly of a building which is exposed to conditioned or semiconditioned space on one side and the outdoor environment on the other.

24. **Thermal Transmission** is the quantity of heat flowing from one space to another through an intermediary element, such as insulation, due to all mechanisms, in unit time,

under the conditions prevailing at that time; expressed as Btu/hr.

25. **Unconditioned Space** is a room or other enclosed space which is not intentionally heated and generally experiences temperatures of 50°F or less.

26. **U-value** is the coefficient of heat transmission from an interior air film to an exterior air film. It is the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films, expressed as Btu/ft•hr•°F. U-value applies to the heat flow path through a single or combination of materials that comprise a building section. U-values can not be added to give a total U-value for an assembly.

27. **U_o-value** is the overall thermal transmittance of a gross area of a thermal envelope, expressed as Btu/ft•hr•°F. U_o-value applies to the combined effect of the time rate of heat flow through various parallel paths.

28. **Vapor Retarder** is a material that impedes transmission of water vapor from one side to the other under specific conditions. Some vapor retarder materials and the way they are applied also function to impede the flow of air from one side to the other.

29. **Wall** is a group of members which define the boundaries of a building or space and which has a slope of 60 degrees or greater from the horizontal plane.

30. **Window Area** is an opening (other than a door) in a wall surface which is glazed with a transparent or translucent material, including the framing or sash.


APPENDIX A
STATEWIDE
REGIONAL INDEX MAP
REGION 5
REGION 4
REGION 3
REGION 2
REGION 1
BEAUFORT SEA
CHUKCHI SEA
BERING STRAIT
BERING SEA
NORTON SOUND
SEWARD PENINSULA
BROOKS RANGE
KUSKOKWIM BAY
BRISTOL BAY
GULF OF ALASKA
U.S.S.R.
ST. ELIAS MOUNTAINS
COAST MOUNTAINS

APPENDIX A
Statewide Regional Index

For your convenience, the following communities have been identified grouped according to the regions shown on the Statewide Regional Index Map.

REGION 1
SOUTHEAST

Angoon
Annette
Annex Creek
Auke Bay
Baranof
Beaver Falls
Bell Island
Alder
Canyon Island
Chenega
Chickagof
Coffman Cove
Craig
Edna Bay
Eldred Rock
Elfin Cove
Five Finger Light Station
Glacier Bay
Gull Cove
Gustavus
Haines
Hollis
Hoonah
Hydaburg
Hyder
Juneau
Kake
Kasaan
Ketchikan
Klawock
Klukwan
Kupreanof
Metlakatla
Myers Chuck
Lincoln Rock Light
Little Port Walter
Moose Valley
Ocean Cape
Pelican
Petersburg
Port Alexander
Port Baker
Port Protection
Saxman
Seclusion Harbor
Sitka
Skagway #2
Smuggler Cove
Snettisham
Tenakee Springs
Thorne Bay
View Cove
Wrangell
Yakutat

REGION 2
SOUTHCENTRAL, ALEUTIAN, KODIAK

Adak
Afognak
Akhiok
Akutan
Anchor Point
Anchorage
Anderson
Atka
Attu
Belkofski
Big Lake
Cape Sarichef
Caswell
Chickaloon
Chignik
Chignik Lake
Chiniak
Chulita
Clam Gulch
Cold Bay
Cold Harbor
Cooper Landing
Cordova
Curry
Diamond Ridge
Driftwood Bay
Dutch Harbor
Eklutna
Elmendorf
English Bay
False Pass
Fort Glenn
Fort Richardson
Girdwood
Homer
Hope
Houston
Ivanoff Bay
Kachemak
Kaguyak
Karluk
Kasilof
Kenai
King Cove
Knik
Kodiak
Kulis ANGB
Larsen Bay
Latouche
Mat. Ag. Exp.
Middleton Island
Moose Pass
Mountain Village
Naptowne
Nelson Lagoon
Nikiski Terminal
Ninilchik
Nikolski
Old Harbor
Ouzinkie
Palmer
Perryville
Petersville
Pillar Mountain
Portage
Port Graham
Port Heiden
Port Lions
Port Moller
Portlock
Rabbit Creek
Salamatof
Sanak
Sand Point
Sawmill
Seldovia
Seward
Shemya
Skwentna
Soldotna
Squaw Harbor
Starisky Creek
Sterling
Summit
Susitna
Sutton
Talkeetna
Tatitlek
Tehneta Pass
Thompson Pass
Trappers Creek Camp
Tyonek
Unalaska
Unga
Island
Valdez
Wasilla
Whittier
Willow
Women's Bay
Yakataga Bay

REGION 3
INTERIOR, SOUTHWEST

Akiachak
Akiak
Alakanuk
Aleknagik
Allakaket
Anderson
Aniak
Anvik
Atmautluak
Aurora
Beaver Creek
Beaver
Beaver Creek
Bethel
Bettles
Big Delta
Big Mountain
Bill Moore's
Birch Creek
Black Rapids
Boundary
Canyon Creek
Cape Newenham
Cape Romanzof
Cathedral Rapids Creek #2
Cantwell
Central
Chalkyitsik
Chandalar
Chandalar Lake
Chatanika
Chauthbaluk
Chefornak
Chena Hot Springs
Chevak
Chicken
Chistochina
Chitina
Chuloonawick
Circle
Circle Hot Springs
Clark's Point
Clear
Coldfoot Camp

APPENDIX A
Statewide Regional Index

College
Copper Center
Crooked Creek
Delta Junction
Dillingham
Donnelly
Dot Lake
Dry Creek
Eagle
Eek
Egegik
Eielson
Ekuk
Ekwok
Emmonak
Creek
Ester
Eureka
Evansville
Fairbanks
Farewell
Ferry
Fort Greeley
Fort Wainwright
Fort Yukon
Fox
Flat
Gakona
Galena
Gerstle River
Georgetown
Glennallen
Gold King Creek
Goodnews Bay
Grayling
Gulkana
Hamilton
Harding Lake
Healy
Healy Lake
Holy Cross
Hooper Bay
Hughes
Huslia
Iguigig
Iliamna
Indian Mountain
Kalskag
Kaltag
Kanatak
Kasigluk
Kennicott
Kenny Lake
King Salmon
Kipnuk
Knob Ridge
Kohkanok
Koliganek
Kongiganak
Kotlik
Koyukuk
Kwethluk
Kwigillingok
Lake Munchumina
Lime Village
Livengood
Lower Kalskag
Lower Tonsina
Manley Hot Spring
Manokotak
Marshall
Ma Creek
McCallum
McCarthy
McGrath
McKinley Park
Medfra
Mekoryuk
Mentasta Lake
Minto
Mountain Village
Murphy Dome
Naknek
Napakiak
Napamiute
Napaskiak
Nebesna
Nenana
Newhalen
New Stuyahok
Newtok
Nightmute
Nikolai
Nondalton
North Pole
Northway
Northway Junction
Nulato
Nunapitchuk
Ohogamiute
Ophir
Oscarville
Paimuit
Paxson
Paxson Lake
Pedro Dome
Pilot Point
Pilot Station
Pitka's Point
Platinum
Port Alsworth
Quinhagak
Rampart
Red Devil
Richardson
Russian Mission
Ruby
Saint George
Saint Mary's
Saint Matthew
Saint Paul Island
Salchaket
Scammon Bay
Shageluk
Sheldon Point
Slana
Sleetmute
Slide Mountain
South Naknek
Sparrevohn
Stevens Village
Stony River
Suntrana
Summit
Takotna
Tanacross
Tanana
Tatalina
Telida
Tetlin
Togiak
Tok
Toksook Bay
Tonsina
Tuluksak
Tununak
Tuntutuliak
Twin Hills
Ugashik
Upper Kalskag
Usibelli
Unkumiute
Venetie
Wiseman

REGION 4
NORTHWEST

Ambler
Anvil Mountain
Brevig Mission
Buckland
Candle
Council
Deering
Diomede
Elim
Gambell
Golovin
Granite Mountain
Haycock
Kalakaket Creek
Kiana
King Island
Kivalina
Kobuk
Kotzebue
Koyuk
Mary's Igloo
Moses Point
Noatak
Nome
Noorvik
Northeast Cape
North River
Savoonga
Selawik
Shaktoolik
Shishmaref
Shungnak
Solomon
Stebbins
St Michael
Teller
Tin City
Unalakleet
Wales
White Mountain

REGION 5
ARCTIC SLOPE

Anaktuvuk Pass
Arctic Village
Atqasut
Barrow
Cape Lisburne
Deadhorse
Kaktovik
Nuiqsut
Oliktok
Point Hope
Point Lay
Prudhoe Bay
Sagwon
Umiat
Wainwright

APPENDIX B

U_o Calculation Example

This is an example of how to calculate a U_o-value for a ceiling with one skylight. U_o-value for a wall or floor may be calculated in a similar manner.

Step 1: Calculate the composite thermal transmittance of all elements of the opaque (nonglazed) ceiling. Don't forget about framing factors.

Ceiling Element	Ceiling R-Value	
	Between Framing	At Framing
Inside air film	0.61	0.61
5/8/" gypsum wall board	0.55	0.55
R-38 fiberglass insulation	38.00	N/A
2x4 bottom chord @ 24" o.c.	N/A	4.35
Fiberglass insulation above truss bottom cord	N/A	27.00
Air film on top of insulation	0.61	0.61
Total R-Value	**39.77**	**33.12**

For a ceiling, the framing factor for 2-inch framing is 6 percent. Therefore:

$$U_{ceiling} = \frac{0.94}{39.77} + \frac{0.06}{33.12} = 0.023 + 0.001 = 0.024$$

Step 2: Find the U-value of the skylight being used. Look in the manufacturer's literature for the specified U-value or R-value. Remember, U = 1/R and R = 1/U. In this case, let's assume an R-2.0 skylight.

Therefore: $U_{skylight} = 1/R = 1/2.0 = 0.500$

Step 3: Calculate the area of the opaque ceiling and the skylight.

a) only one skylight is being used and the area is given by the manufacturer as 8 sq. ft.

b) the gross ceiling area is: 30 ft. x 44 ft. = 1320 sq. ft.

c) therefore, the net ceiling opaque area is: 1320 sq. ft. - 8 sq. ft. = 1312 sq. ft.

Step 4: Calculate the overall thermal transmittance value (U_o) of the ceiling envelope. From Equation 1, Chapter 4:

$$U_o = \frac{(U_{ceiling} \times A_{ceiling}) + (U_{skylight} \times A_{skylight})}{A_o} = \frac{(0.024 \times 1312) + (0.500 \times 8)}{1320}$$

$$= \frac{31.488 + 4}{1320} = 0.026$$

This calculation shows that the resultant ceiling U_o-value of 0.026 exceeds the maximum allowable U_o-value of 0.024 given in Table 4.1. Therefore, the R-value of the R-38 ceiling insulation shall be increased, or the skylight R-value shall be increased, or the skylight area shall be decreased. There is flexibility to change any or all three of the elements until the performance target is achieved.

APPENDIX C
Air Pressure Limitations

Excessive positive or negative air pressure within a building can adversely affect the performance of heating and ventilating equipment, the health and comfort of occupants, and the durability of the structure. The following guidelines, therefore, set pressure limits.

Pressure Increase Limits. Positive pressure in a building can force moist interior air into a ceiling, wall, or floor thereby causing condensation, frost, mold, and wood rot problems. There is also a possibility that the combustion efficiency of some fuel-burning appliances may be adversely affected by excessive pressure.

Therefore, a ventilation system shall be designed so that if operated in a continuous mode the sum of all flows through **supply** air devices shall not exceed the sum of all flows through **exhaust** air devices by more than 0.014 cfm/sq.ft. of interior surface of the building thermal envelope.

Pressure Decrease Limits. In order to avoid dangerous combustion appliance backdrafting, depressurization within a building caused by a mechanical exhaust device is limited as follows:

1) For a building using a Category I fuel-burning appliance, the **reference** exhaust air flow shall not decrease the pressure in the building relative to the outside by more than **5 Pascals of pressure**.

2) For a building using a Category II appliance, the **reference** exhaust air flow shall not decrease the pressure in the building relative to the outside by more than either **10 Pascals of pressure** or the value for which the appliance has been certified by an accredited certification agency.

3) For a building using a Category III appliance, the **reference** exhaust air flow shall not decrease the pressure in the building relative to the outside by more than either **20 Pascals of pressure** or the value for which the appliance has been certified by an accredited certification agency.

4) If no fuel-burning appliance is installed in a building, the **reference** exhaust air flow shall not contribute to decreasing the pressure in the building relative to the outside by more than **20 Pascals of pressure**.

Reference Exhaust Air Flow. In defining the reference exhaust air flow, all powered exhaust appliances that contribute to the **net** exhaust are considered with the exception of a fuel-fired heating appliance. Net exhaust means exhaust air flow in excess of supply air flow. Some appliances, such as heat recovery ventilators, have both supply and exhaust air flow through the appliance. To obtain the reference exhaust air flow:

> Add the **net** exhaust air flow of the ventilation system, the clothes dryer (or 160 cfm if one is not yet installed), and the two additional installed mechanical exhaust devices providing the largest net exhaust air flow (for example, this could be a downdraft cooktop vent and a central vacuum).

Category I Fuel-burning Appliance. This appliance takes combustion air and chimney draft dilution air from within a building, is installed with a draft hood, draft regulator, or other means of allowing for regulation of dilution air, and depends upon natural draft to vent products of combustion to the outdoors. For example, such an appliance includes a fireplace, wood stove, natural draft furnace, boiler, water heater, or gas range. This type of combustion appliance is the most sensitive to backdrafting.

Category II Fuel-burning Appliance. This appliance takes combustion air from a building, but has a sealed, gas-tight, corrosion-resistant flue without any openings through which combustion gases can backdraft into the building. Such an appliance includes a forced draft or induced draft heater.

Category III Fuel-burning Appliance. This appliance takes combustion air directly from outside through a connection sealed from the atmosphere in the building, has a sealed, gas tight, corrosion-resistant flue without any openings through which combustion gases can backdraft into the building. This type of appliance is the least sensitive to backdrafting.

Make-up Air and Pressure Relief Vents. A makeup air or pressure relief vent may need to be provided to keep a building pressure within the limits given in **Pressure Increase Limits** and **Pressure Decrease Limits** above. The table below may be used to size an air vent. A design may require this vent to function for both make-up air and pressure relief. An air vent shall be placed where cold incoming air does not discomfort occupants. An example of how to determine indoor pressures and how to size a make-up or relief air vent is included in the Alaska Craftsman Home Building Manual.

Maximum Passive Air Flow Met By Relief Or Make-up Air Vents

Vent Diameter (inches)	ELA* (in.^{2})	Air Flow Met By Vent** (cfm) Pressure Difference		
		5 Pa (.02" WG)	10 Pa (.04" WG)	20 Pa (.08" WG)
3	7	8	10	19
4	13	16	23	38
5	20	31	46	67
6	28	53	74	114
7	38	85	106	169
8	50	116	159	254
9	64	169	233	318
10	79	212	296	445

* ELA means equivalent leakage area.

** Calculated flow rates for passive make-up or relief air vents assuming an equivalent length of 66 feet. If more airflow is needed than shown, use two or more vents spaced throughout the building.