ORDINANCE No. 115641

COUNCIL BILL No. 108532

AN ORDINANCE relating to energy-efficiency, energy conservation, indoor air quality and ventilation in building construction; amending Section 22.700.010 Seattle Municipal Code ("SMC") to adopt by reference the 1989 Model Energy Code; amending Sections 101, 103, 104, 105, 106, 201, 302, 303, 401, 402, 502, 503, 504, and 505 and Chapters 4, 5 and 7, repealing Section 403, Chapter 6, and the Appendix, adding new Sections 107, 108, 109, 202 and new Chapters 8, 9 and 10 to the Model Energy Code to incorporate the minimum requirements of the 1991 Washington State Energy Code (Chapter 51-11 WAC) and the Washington State Water Conservation Performance Standards (SHB 1397 and WAC 51-18), and to revise the requirements for Other than Group R Occupancy; amending Sections 403, 404, 405, 406, 408, 410, 415, 417, 420, 421, 422, 423, 424, 425, 426, 601, 602, and 604 of the Seattle Mechanical Code and adding a new Chapter 10.1 to the Seattle Mechanical Code to incorporate the 1991 Washington State Ventilation and Indoor Air Quality Code (Chapter 51-13 WAC); amending Sections 605, 705, 905 and 1205 of the Seattle Building Code and adding new Sections 1720 and 1721 to the Seattle Building
rect cross-references to the Seattle Mechanical
incorporate provisions of the 1991 Washington S
Ventilation and Indoor Air Quality Code; and am
Sections 22.100.010 and 22.400.010.

COMPTROLLER FILE No. 299901

Introduced: APR 1 2 1991	By: SMITH
Referred: APR 1 2 1991	To: Utilities
Referred:	To:
Referred:	To:
Reported: MAY 1 1 1991	Second Reading: MAY 1 3 1991
Third Reading: MAY 1 3 1991	Signed: MAY 1 3 1991
Presented to Mayor: MAY 1 3 1991	Approved: MAY 1 7 1991
Returned to City Clerk: MAY 2 7 1991	Published:
Vetoed by Mayor:	Veto Published:
Passed over Veto:	Veto Sustained:

OK

Honorable President:

Your Committee on

to which was referred the within Cou
report that we have considered the sa

5/1/91 - Do P

Full Council date

0890KT

Law Department

The City of Seattle--Legislative Department

0 and 1721 to the Seattle Building Code to cor-
eferences to the Seattle Mechanical Code and to
provisions of the 1991 Washington State
and Indoor Air Quality Code; and amend SMC
100.010 and 22.400.010.

Date Reported
and Adopted

REPORT OF COMMITTEE

President: MB CF held

mittee on

was referred the within Council Bill No.

t we have considered the same and respectfully recommend that the same:

/91 - Do Pass - Utility Committee

Consent vote, 8-0

Committee Chair

ORDINANCE 115641

AN ORDINANCE relating to energy-efficiency, energy conservation, indoor air quality and ventilation in building construction; amending Section 22.700.010 Seattle Municipal Code ("SMC") to adopt by reference the 1989 Model Energy Code; amending Sections 101, 103, 104, 105, 106, 201, 302, 303, 401, 402, 502, 503, 504, and 505 and Chapters 4, 5 and 7, repealing Section 403, Chapter 6, and the Appendix, adding new Sections 107, 108, 109, 202 and new Chapters 8, 9 and 10 to the Model Energy Code to incorporate the minimum requirements of the 1991 Washington State Energy Code (Chapter 51-11 WAC) and the Washington State Water Conservation Performance Standards (SHB 1397 and WAC 51-18), and to revise the requirements for Other than Group R Occupancy; amending Sections 403, 404, 405, 406, 408, 410, 415, 417, 420, 421, 422, 423, 424, 425, 426, 601, 602, and 604 of the Seattle Mechanical Code and adding a new Chapter 10.1 to the Seattle Mechanical Code to incorporate the 1991 Washington State Ventilation and Indoor Air Quality Code (Chapter 51-13 WAC); amending Sections 605, 705, 905 and 1205 of the Seattle Building Code and adding new Sections 1720 and 1721 to the Seattle Building Code to correct cross-references to the Seattle Mechanical Code and to incorporate provisions of the 1991 Washington State Ventilation and Indoor Air Quality Code; and amending SMC Sections 22.100.010 and 22.400.010.

BE IT ORDAINED BY THE CITY OF SEATTLE AS FOLLOWS:

Section 1. As of July 1, 1991, Section 22.700.010, SMC, as last amended by Ordinance 113059, is further amended as follows:

22.700.010 Adoption of the Model Energy Code and State and local amendments.

The Model Energy Code ((~~1986~~)) 1989 Edition, published by the Council of American Building Officials, and the amendments thereto adopted by Ordinance ((~~113059~~)) 115641 incorporating the Seattle Amendments ((~~and~~)), the Washington State residential requirements of RCW 19.27A.020 ((~~(1)(a) and (b)~~)) (4) and the Washington State Energy Code and the Washington State Water Conservation Performance Standards (RCW 19.27.170 and WAC 51-18), copies of which are filed with the City Comptroller in C.F. ((~~295167~~)) 298901 are hereby adopted and by this reference made a part of this subtitle and shall constitute the official Energy Code of the City.

Section 2. As of July 1, 1991, Section 101 of the 1989 Model Energy Code is amended as follows:

CHAPTER 1
ADMINISTRATION AND ENFORCEMENT

SECTION 101 - SCOPE AND GENERAL REQUIREMENTS

101.1 Title: This code shall be known as the ((~~Model~~)) Seattle Energy Code, and may be cited as such. It is referred to herein as "this code."

CS 19.2

101.2 Intent: The purpose of this code is to provide minimum standards for new or altered buildings and structures or portions thereof to achieve efficient use of energy.

The provisions of this code shall regulate the design of building envelopes for adequate thermal resistance and low air leakage and the design and selection of mechanical, electrical, service water-heating and illumination systems and equipment which will enable effective use of energy in new building construction and existing buildings to the extent that they are regulated by Section 101.3.2 consistent with a healthful environment.

It is intended that these provisions provide flexibility to permit the use of innovative approaches and techniques to achieve effective utilization of energy. These provisions are structured to permit compliance with the intent of this code by ((~~any one~~)) either of the following ((~~three~~)) two paths of design:

- A systems approach for the entire building and its energy-using sub-systems which may utilize nondepletable sources, Chapter 4.
- A prescriptive/component performance approach for various building elements and mechanical systems and components, Chapter 5.

((~~- Specified acceptable practice, Chapter 6.~~))

Compliance with ((~~any one~~)) either of these paths meets the intent of this code. This code is not intended to abridge safety, health or environmental requirements required under other applicable codes or ordinances.

101.3 Scope: This code sets forth minimum requirements for the design of new buildings and structures or portions thereof and additions, alterations and repairs to existing buildings that provide facilities or shelter for public assembly, educational, business, mercantile, institutional, storage and residential occupancies, as well as ((~~those portions of~~)) factory and industrial occupancies ((~~designed primarily for human occupancy~~)), by regulating their exterior envelopes and the selection of their HVAC, service water heating, electrical distribution and illuminating systems and equipment for auxiliaries for effective use of energy.

Buildings shall be designed to comply with the requirements of Chapter 4((~~,~~)) or 5 ((~~or 6~~)) of this code.

This code is intended to supplement the provisions of the Seattle Building Code, the Seattle Mechanical Code, and the Seattle Electrical Code, and in case of conflict between this code and any of those codes, the provisions of those codes shall apply. Additional efficiency standards for electrical energy use may also appear in Seattle City Light service requirements, which should be consulted.

101.3.1 Exempt buildings: Buildings and structures or portions thereof meeting any of the following criteria shall be exempt from the requirements of Section 502, but shall be included in any analysis performed pursuant to Chapter 4 and shall comply with all other requirements for building mechanical systems, service water heating and lighting systems.

101.3.1.1: Buildings and structures or portions thereof whose peak design rate of energy usage is less than 3.4 Btu/h per

square foot or 1.0 watt per square foot of floor area for ((~~all purposes~~)) space conditioning requirements.

101.3.1.2: For Group R Occupancy only, ((~~B~~))buildings and structures or portions thereof which are neither heated according to the definition of heated space in Chapter 2, nor cooled, by a non-renewable energy source, provided that the non-renewable energy use for space conditioning complies with the requirements of Section 101.3.1.1.

101.3.1.3: Greenhouses isolated from any conditioned space and not intended for occupancy.

101.3.2 Application to existing buildings: Additions, historic buildings, changes of occupancy or use, and alterations or repairs shall comply with the requirements in the subsections below.

> **Exception:** The building official may approve designs of alterations or repairs which do not fully conform with all of the requirements of this code where in the opinion of the building official full compliance is physically impossible and/or economically impractical and:
>
> 1. The alteration or repair improves the energy efficiency of the building; or
>
> 2. The alteration or repair is energy efficient and is necessary for the health, safety, and welfare of the general public.

In no case, shall building envelope requirements or mechanical system requirements be less than those requirements in effect at the time of the initial construction of the building.

101.3.2.1 Additions to existing buildings: Additions to existing buildings or structures may be made to such buildings or structures without making the entire building or structure comply((~~,~~)), provided that ((~~T~~))the new addition shall conform to the provisions of this code ((~~as they relate to new construction only~~)).

> **Exception:** New additions which do not fully comply with the requirements of this code and which have a floor area which is less than 750 square feet shall be approved provided that improvements are made to the existing occupancy to compensate for any deficiencies in the new addition. Compliance shall be demonstrated by either systems analysis or component performance calculations. The nonconforming addition and upgraded, existing occupancy shall have an energy budget or heat loss which is less than or equal to the unimproved existing building, with the addition designed to comply with this code.

101.3.2.2 Historic buildings: The building official may modify the specific requirements of this code for ((~~H~~))historic buildings ((~~are exempt from this code~~)) and require in lieu thereof alternate requirements which will result in a reasonable degree of energy efficiency. This ((~~exemption shall apply to~~)) modification may be allowed for those buildings which have been specifically designated as historically significant by the state or local governing body, or listed in "The National Register of Historic Places" or which have been determined to be eligible for listing. A certificate of approval from the Landmarks

Preservation Board may be required prior to alteration of the building.

101.3.2.3 Change of occupancy or use: ((~~A change in the occupancy or use of an existing building or structure constructed under this code which would require an increase in demand for either fossil fuel or electrical energy supply shall not be permitted unless such building or structure is made to comply with the requirements of this code.~~))

1. Any Other than Group R occupancy which is presently unconditioned where the occupancy or use is changed to require conditioning shall be required to be brought into full compliance with this code.

2. The use or occupancy of any Other than Group R Occupancies which are presently conditioned may be changed without complying with this code, provided additional heat or cooling is not added.

3. Any Other than Group R Occupancy which is converted to Group R occupancy shall be brought into full compliance with this code.

4. Any Group R Occupancy which is converted to Other than Group R Occupancy shall be required to comply with all of the provisions of this code if either new or increased heating or cooling is provided.

5. All Occupancies, which are converted from a Group R Occupancy or an Other than Group R Occupancy or use, to a new Other than Group R Occupancy or use shall comply with the lighting standards set forth in this code unless the existing lighting is not altered.

101.3.2.4 Alterations and repairs: All alterations and repairs to buildings or portions thereof originally constructed subject to the requirements of this code shall conform to the provisions of this code without exception. For all other existing buildings, initial tenant alterations shall comply with the new construction requirements of this code. Other alterations and repairs may be made to existing buildings and moved buildings without making the entire building comply with all of the requirements of this code for new buildings, provided the following requirements of Subsections 101.3.2.5, 101.3.2.6, 101.3.2.7 and 101.3.2.8 are met:

101.3.2.5 Building envelope: The result of the alterations or repairs both:

1. Improves the energy efficiency of the building, and

2. Complies with (a) the nominal R-values and glazing requirements of the reference case in Table Nos. 6-1 to 6-6 or 5-2, or (b) the overall average thermal transmittance values of the elements of the exterior building envelope in Table No. 5-1 or 5-2 of Chapter 5.

Exceptions

1. Untested storm windows may be installed over existing glazing for an assumed U-value of 0.90, however, where glass and sash are being replaced in Group R Occupancy, glazing with a maximum area weighted average U-value of

0.40 shall be installed where there is an electric resistance space heating system and glazing with a maximum U-value of 0.65 shall be installed where there is any other space heating system.

2. Where the structural elements of the altered portions of roof/ceiling, wall or floor are not being replaced, these elements shall be deemed to comply with this code if all existing framing cavities which are exposed during construction are filled to the full depth with batt insulation or insulation having an equivalent nominal R value while, for roof/ceilings, maintaining the required space for ventilation. Existing walls and floors without framing cavities need not be insulated. Existing roofs shall be insulated to the requirements of this code if:

   (a) The roof is uninsulated or insulation is removed to the level of the sheathing, or

   (b) All insulation in the roof/ceiling was previously installed exterior to the sheathing or non-existent.

3. For other than Group R occupancy, new glazing need not comply with the shading coefficient as long as it is equal to or lower than that of the other existing glazing. It shall not be higher than the shading coefficient of other existing glazing unless the glazing area, U-value and shading coefficient all comply with one of the packages listed in Table No. 5-2.

101.3.2.6 Building mechanical systems: Those systems or parts of systems which are altered or replaced shall comply with Section 503.

101.3.2.7 Service water heating: Those systems or parts of systems which are altered or replaced shall comply with Section 504.

101.3.2.8 Lighting: Those parts of systems which are altered or replaced in buildings initially constructed subject to the requirements of this code shall comply with Section 505. Other remodels or replacements of lighting systems which are part of a substantial remodel shall comply with Section 505. For any other remodels, the installed watts per square foot shall be maintained or reduced. Remodeling of any sized area, with or without putting in a new ceiling grid or suspension system, when reusing existing fixtures and/or adding new ones, shall not require compliance with the lighting power budget as long as the installed lighting wattage is maintained or reduced. Remodeling of an entire floor or entire tenant space that includes a new lighting system, with or without a new ceiling grid or suspension system, does require compliance with the lighting power budget of Section 505. Compliance with switching requirements of Section 505 is only required when new wiring is being run related to adding fixtures and/or fixtures are being relocated to a new circuit.

101.3.3 Mixed occupancy: When a building houses more than one occupancy, each portion of the building shall conform to the requirements for the occupancy housed therein. Where minor accessory uses do not occupy more than 10 percent of the area of any floor of a building, the major use ((~~shall~~)) may be considered the building occupancy.

Section 3: As of July 1, 1991, Section 103 of the 1989 Model Energy Code is amended as follows:

SECTION 103 - ALTERNATE MATERIALS-METHOD OF CONSTRUCTION, DESIGN OR INSULATING SYSTEMS

The provisions of this code are not intended to prevent the use of any material, method of construction, design or insulating system not specifically prescribed herein, provided that such construction, design or insulating system has been approved by the building official as meeting the intent of the code. The building official may approve any such alternate provided the building official finds the proposed alternate meets or exceeds the provisions of this code and that the material, method, design or work offered is for the purpose intended, at least the equivalent of that prescribed in this code, in quality, strength, effectiveness, fire-resistance, durability, safety, and efficient use and conservation of energy. The building official may require that sufficient evidence of proof be submitted to substantiate any claims that may be made regarding performance capabilities.

Section 4: As of July 1, 1991, Section 104 of the 1989 Model Energy Code is amended as follows:

SECTION 104 - PLANS AND SPECIFICATIONS

104.1 General: With each application for a ((~~building~~)) permit, for the codes listed in Section 101.3 ((~~and when required by the building official,~~)) plans, ((~~and~~)) specifications and calculations shall be submitted in accordance with the reference code and showing information pertinent to the applicable sections of this code. ((~~The building official may require plans and specifications be prepared by an engineer or architect licensed to practice by the state.~~)) (Designs submitted under the provisions of Chapter 4 shall be prepared by an engineer or architect licensed to practice by the state.) Submission of all pertinent information shall be a condition precedent to the processing of any of the above permits and approval of the submitted information shall be a condition precedent to the issuance of any of the above permits.

104.2 Details: The plans and specifications shall show in sufficient detail pertinent data and features of the building and the equipment and systems as herein governed, including, but not limited to: design criteria, exterior envelope component materials, U-values of the envelope systems, R values of insulating materials, size and type of apparatus and equipment, equipment and systems controls and other pertinent data to indicate conformance with the requirements of the code.

Section 5: As of July 1, 1991, Section 105 of the 1989 Model Energy Code is amended as follows:

SECTION 105 - ENFORCEMENT AND INSPECTIONS

105.1 General: The building official is authorized and directed to enforce this code. Construction or work for which a permit is required shall be subject to inspection by the building official

in connection with inspections performed pursuant to the building, mechanical and electrical codes and all such construction or work shall remain accessible and exposed for inspection purposes until approved by the building official.

105.2 Approvals required: No work shall be done on any part of the building or structure beyond the point indicated in each successive inspection without first obtaining the written approval of the building official. No construction shall be concealed without inspection approval.

105.2.1 Required inspections: The building official, upon notification, shall make the following inspection in addition to those inspections required in Section 305(e) of the Seattle Building Code:

1. Wall insulation inspection: To be made after all wall insulation and air vapor retarder sheet or film materials are in place, but before any wall covering is placed.

105.3 Final inspection: There shall be a final inspection and approval for buildings when completed and ready for occupancy.

105.4 Reinspection: The building official may cause a structure to be reinspected.

105.5 Authority: The building official is authorized and directed to promulgate, adopt, and issue those rules and regulations necessary to the effective and efficient administration of this code, which may include:

- "Building construction standards" to promulgate standards which are acceptable as a method or as an alternative design for meeting code required performance criteria, or to edit or update national standards which are referenced in this code.
- "Director's rules" to interpret and clarify conditions or language expressed in the building construction codes.
- "Product approvals" to approve a specific building construction material or product, or a particular component fabricator which has been found acceptable as meeting building construction codes' required performance criteria.

The building official shall promulgate, adopt and issue rules according to the procedures as specified in the Administrative Code of the City of Seattle, as amended.

Section 6: As of July 1, 1991, Section 106 of the 1989 Model Energy Code is amended as follows:

SECTION 106 - VALIDITY

If a section, subsection, sentence, clause or phrase of this code is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this code. The legislative body hereby declares that it would have passed this code, and each section, subsection, clause or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses, and phrases be declared unconstitutional.

If any provisions of this code or its application to any person or circumstance is held invalid, the remainder of this code or the application of the provision to other persons or circumstances is not affected.

Section 7: As of July 1, 1991, a new Section 107 is added to the 1989 Model Energy Code as follows:

SECTION 107 - LIABILITY

Nothing contained in this code is intended to be nor shall be construed to create or form the basis for any liability on the part of the City, or its officers, employees or agents, for any injury or damage resulting from the failure of a building to conform to the provisions of this code, or by reason of or in consequence of any inspection, notice, order, certificate, permission of approval authorized or issued or done in connection with the implementation or enforcement of this code, or by reason of any action or inaction on the part of the City related in any manner to the enforcement of this code or by its officers or agents. The building official or any employee charged with the enforcement of this code, acting in good faith and without malice for the City in the discharge of his/her duties, shall not thereby render himself/herself liable personally and he/she is hereby relieved from all personal liability for any damage that may accrue to persons or property as a result of any act required or by reason of any act or omission in the discharge of his/her duties.

Section 8: As of July 1, 1991, a new Section 108 is added to the 1989 Model Energy Code as follows:

SECTION 108 - CONFLICTS WITH OTHER CODES

In addition to the requirements of this code, all occupancies shall conform to the provisions included in the State Building Code (Chapter 19.27 RCW) and Uniform Building Code and Standards Adoption and Amendment rules and (Chapter 51-16 WAC). In case of conflicts among codes enumerated in RCW 19.27.031 subsections (1), (2), (3) and (4) and this code, the first named code shall govern over the following. Provided, in the case of conflict between the duct insulation requirements of this code and the duct insulation requirements of Section 1005 of the Uniform Mechanical Code, the duct insulation requirements of this code shall govern.

Where, in any specific case, different sections of this code specify different materials methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Wherever in this code reference is made to the appendix, the provisions in the appendix shall not apply unless specifically adopted.

Section 9: As of July 1, 1991, a new Section 109 is added to the 1989 Model Energy Code as follows:

SECTION 109 - VIOLATIONS AND PENALTIES

109.1 Violations: It shall be a violation of this code for any person, firm or corporation to erect, construct, enlarge, repair, move, improve, remove, convert or demolish, equip, occupy, inspect or maintain any building or structure in the city, contrary to or in violation of any of the provisions of this code.

It shall be a violation of this code for any person, firm or corporation to aid, abet, counsel, encourage, hire, commend, induce or otherwise procure another to violate or fail to comply with this code.

It shall be a violation of this code for any person, firm or corporation to use any material or to install any device, appliance or equipment which does not comply with applicable standards of this code or which has not been approved by the building official.

109.2 Civil penalty: Any person, firm or corporation failing to comply with the provisions of this code shall be subject to a cumulative penalty in an amount not to exceed $500 per day for each violation from the date compliance is required by the building official until compliance is achieved.

109.3 Criminal penalties

109.3.1: Anyone violating or failing to comply with any order issued by the building official pursuant to this code shall, upon conviction thereof, be punished by a fine of not more than $1,000 or by imprisonment for not more than 360 days, or by both such fine and imprisonment. Each day's violation or failure to comply shall constitute a separate offense.

109.3.2: Anyone violating or failing to comply with any of the provisions of this code and who within the past five years has had a judgement against them pursuant to Section 107.2, shall upon conviction thereof be fined a sum not to exceed $500 or by imprisonment for not more than 180 days, or by both such fine and imprisonment. Each day's violation or failure to comply shall constitute a separate offense.

109.4 Additional relief: The building official may seek legal or equitable relief to enjoin any acts or practices and abate any condition which constitutes a violation of this building code when civil or criminal penalties are inadequate to effect compliance.

Section 10: As of July 1, 1991, Section 201 of the 1989 Model Energy Code is amended as follows:

CHAPTER 2
DEFINITIONS

SECTION 201 - GENERAL DEFINITIONS

201.1 Application of terms: For the purposes of this code, certain abbreviations, terms, phrases, words and their derivatives,

shall be as set forth in this chapter. Where terms are not defined, they shall have their ordinary accepted meanings within the context with which they are used. In the event there is a question about the definition of a term, the definitions for terms in the codes enumberated in RCW 19.27.031 and the edition of Webster's dictionary referenced therein shall be considered as the sources for providing ordinarily accepted meanings.

AAMA: American Architectural Manufacturers Association.

Accepted analysis methods: Heating/cooling and lighting load calculations performed in accordance with the most current procedures developed by a nationally recognized professional organization and approved by the building official.

((~~Accessible (as applied to equipment): Admitting close approach because not guarded by locked doors, elevation or other effective means (see "Readily accessible").~~))

Addition: See the Seattle Building Code.

Advanced framed ceiling: Advanced framing assumes full and even depth of insulation extending to the outside edge of exterior walls (see "Standard framing").

Advanced framed walls: Studs framed on twenty-four-inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and one stud is used to support each header. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

AFUE - Annual fuel utilization efficiency: Unlike steady state conditions, this rating is based on average usage including on and off cycling as set out in the standardized Department of Energy Test Procedures.

Air conditioning, comfort: The process of treating air so as to control simultaneously its temperature, humidity, cleanliness and distribution to meet requirements of the conditioned space.

((~~Air transport factor: The ratio of the rate of useful sensible heat removal from the conditioned space to the energy input to the supply and return fan motor(s), expressed in consistent units and under the designated operating conditions.~~))

ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

ASTM: American Society for Testing and Materials.

Automatic: Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration (see "Manual").

Ballast: A device used to obtain the necessary circuit conditions (voltage, current, and wave form) for starting and operating an electric-discharge lamp.

Basement wall: The opaque portion of a wall which encloses a basement and is partially or totally below grade.

Below grade wall: A wall or the portion of a wall which is entirely below the finish grade or which extends two feet or more below the finish grade (see "Exterior wall").

Boiler capacity: The rate of heat output in Btu/h measured at the boiler outlet, at the design inlet and outlet conditions and rated fuel/energy input.

British thermal unit (Btu): See the Seattle Mechanical Code.

Budget Energy Consumption (BECON): The computed annual energy expenditure of a standard, either prototype or reference, building design ($Btu/ft^2 \cdot yr$).

Building, existing: See the Seattle Building Code.

Building envelope: The elements of a building which enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from spaces exempted by the provisions of Section 101.3.1.

Building official: ((~~The official authorized to act in behalf of the responsible government agency for the enforcement of this code.~~)) The Director of the Department of Construction and Land Use and authorized representatives of the Director of the Department of Construction and Land Use.

Building project: A building or group of buildings, including on-site energy conversion or electric-generating facilities, which utilize a single submittal for a construction permit or are within the boundary of a contiguous area under one ownership.

Building type: The classification of a building by usage as follows:

(a) **assembly:** a building or structure for the gathering together of persons, such as auditoriums, churches, dance halls, gymnasiums, theaters, museums, passenger depots, sports facilities, and public assembly halls

(b) **health and institutional:** a building or structure for the purpose of providing medical treatment, confinement or care, and sleeping facilities such as hospitals, sanitariums, clinics, orphanages, nursing homes, mental institutions, reformatories, jails, and prisons

(c) **hotel or motel:** a building or structure for transient occupancy, such as resorts, hotels, motels, barracks, or dormitories

(d) **light manufacturing:** a facility where products are assembled with minimal use of process energy and where conditioning for human comfort is provided throughout the majority of the facility.

(e) **multifamily:** a building or structure containing three or more dwelling units (see "Dwelling unit")

(f) **office (business):** a building or structure for office, professional, or service type transactions; such as medical offices, banks, libraries, and governmental office buildings

(g) **restaurant:** a building or a structure for the consumption of food or drink, including fast food, coffee shops, cafeterias, bars, and restaurants

(h) **retail (mercantile):** a building or structure for the display and sale (wholesale or retail) of merchandise such as shopping malls, food markets, auto dealerships, department stores, and specialty shops

(i) **school (educational):** a building or structure for the purpose of instruction such as schools, colleges, universities, and academies

(j) **warehouse (storage):** a building or structure for storage, such as aircraft hangers, garages, warehouses, storage buildings, and freight depots.

Clerestory: A window placed in a wall projecting from a roof plane at sixty (60) degrees or more from the horizontal to admit daylight into the interior of a building (see "Skylight").

((~~Coefficient of beam utilization (CBU): The ratio of the luminous flux (lumens) reaching a specified area directly from a floodlight or projector to the total beam luminous flux.~~))

((~~Coefficient of performance (COP): See the following sections in Chapter 5 for the definitions of COP as appropriate:~~

~~Electrically Operated HVAC System Equipment -- Cooling~~	~~503.4.5.2~~
~~Applied HVAC System Components -- Cooling~~	~~503.4.6.1~~
~~Heat-operated HVAC System Equipment -- Cooling~~	~~503.4.7 and Footnote 2 of Table No. 503.4.7~~
~~Heat Pump -- Heating~~	~~503.4.2.2~~))

Coefficient of performance (COP) -- cooling: The ratio of the rate of heat removal to the rate of energy input in consistent units, for a complete cooling system or factory assembled equipment, as tested under a nationally recognized standard or designated operating conditions.

Coefficient of performance (COP), heat pump -- heating: The ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system under designated operating conditions. Supplemental heat shall not be considered when checking compliance with the heat pump equipment COPs listed in the tables in Section 503.

((~~Coefficient of utilization (CU): The ratio of the luminous flux (lumens) from a luminaire received on the work plane to the lumens emitted by the luminaire's lamps alone.~~))

((~~Color rendition: General expression for the effect of a light source on the color appearance of objects in conscious or subconscious comparison with their color appearance under a reference light source.~~))

Comfort envelope: The area on a psychrometric chart enclosing all those conditions described in Figure No. 1 in Standard RS-4 listed in Chapter 7, as being comfortable.

Conditioned floor area: See "Gross conditioned floor area".

Conditioned space (Group R Occupancy): All spaces ((~~within a building~~)) which ((~~is~~)) are provided with heated and/or cooled air or ((~~surfaces and, where required, with humidification or dehumidification means so as to be capable of maintaining a space condition falling within the comfort zone set forth in Standard RS-4 listed in Chapter 7~~)) which are capable of being maintained at temperatures over 50 degrees F during the heating season, including adjacent connected spaces separated by an uninsulated component (e.g., basements, utility rooms, garages, corridors).

Conditioned space (Other than Group R Occupancy): A cooled space, heated space, or indirectly conditioned space.

Connected lighting power (CLP): The power required to energize non-portable luminaires and lamps permanently connected to the building electrical service, in Watts.

Continuous air barrier: A system of materials installed during construction that is designed to effectively minimize the transfer of air to or from the conditioned space though unintentional openings in the building envelope.

Cooled space (Group R Occupancy): Space within a building which is provided with a positive cooling supply.

Cooled space (Other than Group R Occupancy): An enclosed space within a building that is cooled by a cooling system whose sensible capacity

(a) exceeds 5 Btu/(h·ft^2) or

(b) is capable of maintaining space dry bulb temperature of 90 degrees F or less at design cooling conditions.

((~~Crawl space wall: The opaque portion of a wall which encloses a crawl space and is partially or totally below grade.~~))

Daylighted zone:

(a) **under skylights:** the area under each skylight whose horizontal dimension in each direction is equal to the skylight dimension in that direction plus either the floor to ceiling height or the dimension to an opaque partition, or one-half the distance to an adjacent skylight or vertical glazing, whichever is least.

(b) **at vertical glazing:** the area adjacent to vertical glazing which receives daylighting from the glazing. For purposes of this definition and unless more detailed daylighting analysis is provided, the daylighting zone depth is assumed to extend into the space a distance of 15 feet or to the nearest opaque partition, whichever is less. The daylighting zone width is assumed to be the width of the window plus either two feet on each side (the distance to an opaque partition) or one half the distance to an adjacent skylight or vertical glazing whichever is least.

Daylight sensing control (DS): a device that automatically regulates the power input to electric lighting near the fenestration to maintain the desired workplace illumination, thus taking advantage of direct or indirect sunlight.

Deadband: The temperature range in which no heating or cooling is used.

Default assumption: The value of an input used in a calculation procedure when a value is not entered by the designer.

Degree day, cooling: A unit, based upon temperature difference and time, used in estimating cooling energy consumption. For any one day, when the mean temperature is more than a reference temperature, typically 65 degrees F, there are as many Degree Days as degrees Fahrenheit temperature difference between the mean temperature for the day and the reference temperature. Annual Cooling Degree Days (CDD) are the sum of the degree days over a calendar year.

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

Design conditions: the exterior and interior environmental parameters specified for air-conditioning and electrical design for a facility.

Design energy consumption (DECON): The computed annual energy expenditure of a proposed building design (Btu/ft^2·yr).

Door: All operable openings not included in the glazing area (see "Glazing area".)

Door area: Total area of door measured using the rough opening and including the door and frame.

Dwelling unit: ((A ~~single housekeeping unit comprised of one or more rooms providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.~~)) See the Seattle Building Code.

Economizer, air: A ducting arrangement and automatic control system that allows a cooling supply fan system to supply outside air to reduce or eliminate the need for mechanical refrigeration during mild or cold weather.

Economizer, water: A system by which the supply air of a cooling system is cooled directly or indirectly or both by evaporation of water or by other appropriate fluid (in order to reduce or eliminate the need for mechanical refrigeration).

Efficiency, HVAC system: The ratio of useful energy (at the point of use) to the energy input for a designated time period, expressed in percent.

Emergency system (back up system): A system that exists for the purpose of operating in the event of failure of a primary system.

Emissivity: The ability to absorb infrared radiation. A low emissivity implies a higher reflectance of infrared radiation.

Energy: The capacity for doing work; taking a number of forms which may be transformed from one into another, such as thermal (heat), mechanical (work), electrical and chemical; in customary units, measured in kilowatt-hours (kWh) or British thermal units (Btu)(see "New energy").

Energy, recovered: See "Recovered energy."

Energy efficiency ratio (EER): The ratio of net equipment cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions. When consistent units are used, this ratio becomes equal to COP. (See also "Coefficient of performance".)

Energy management system: A control system designed to monitor the environment and the use of energy in a facility and to adjust the parameters of local control loops to conserve energy while maintaining a suitable environment.

Enthalpy: A thermodynamic property of a substance defined as the sum of its internal energy plus the quantity Pv/J, where P is the pressure of the substance, v is its specific volume, and J is the mechanical equivalent of heat; formerly called total heat and heat content.

((~~Equivalent sphere illumination (ESI): The level of sphere illumination which would produce task visibility equivalent to that produced by a specific lighting environment.~~))

Exfiltration: The uncontrolled outward air leakage through cracks and interstices in any building element such as around soleplates, wall outlets, duct systems, windows and doors of a building, caused by the pressure effects of wind and/or the effect of differences in the indoor and outdoor air density.

Existing building: See the Seattle Building Code.

Exterior envelope: See "Building envelope."

Exterior lighting power allowance (ELPA): The calculated maximum lighting power allowance for an exterior area of a building or facility, in Watts.

Exterior wall: A wall or section thereof which is exposed to outdoor air and encloses conditioned space (see "Below grade wall").

Fenestration: Any light-transmitting section in a building wall or roof. The fenestration includes glazing material (which may be glass or plastic) and framing (mullions, muntins, and dividers).

Fenestration area: The total area of fenestration measured using the rough opening and including the glass or plastic, sash, and frame.

((~~Floodlighting: A lighting system designated to light an area using projector-type luminaires usually capable of being pointed in any direction.~~))

Floor over unconditioned space: A floor which separates a conditioned space from an unconditioned space which is buffered from exterior ambient conditions including vented crawlspaces and unconditioned basements or other similar spaces, or exposed to

exterior ambient conditions including open parking garages and enclosed garages which are mechanically ventilated.

F-Value: The perimeter heat loss factor expressed in Btu/hr·ft·°F.

General lighting: Lighting designed to provide an approximately uniform level of illumination in an area.

Glazing: All areas, including the frames, in the shell of a conditioned space that let in natural light, including windows, clerestories, skylights, sliding or swinging glass doors and glass block walls.

Glazing area: Total area of glazing measured using the rough opening, and including the glass, the sash and the frame. For doors where the daylight opening area is less than fifty percent of the door area, the glazing area is the daylight opening area. For all other doors, the glazing area is the door area (see "Door area").

Gross conditioned floor area: The horizontal projection of that portion of interior space which is contained within exterior walls and which is conditioned directly or indirectly by an energy-using system, and which has an average height of five feet or greater, measured from the exterior faces.

Gross exterior wall area: The normal projection of the building envelope wall area bounding interior space which is conditioned by an energy-using system; includes opaque wall, window and door area.

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

Gross floor area: The sum of the areas of the several floors of the building, including basements, cellars, mezzanine and intermediate floored tiers and penthouses of headroom height, measured from the exterior faces of exterior walls or from the center line of walls separating buildings, but excluding:

- Covered walkways, open roofed-over areas, porches and similar spaces.
- Pipe trenches, exterior terraces or steps, chimneys, roof overhangs and similar features.

Gross roof/ceiling ((~~assembly~~)) **area:** A roof/ceiling assembly shall be considered as all components of the roof/ceiling envelope through which heat flows, thus creating a building transmission heat loss or gain, where such assembly is exposed to ((~~outdoor air~~)) exterior ambient conditions and encloses a ((~~heated or mechanically cooled~~)) conditioned space. This does

not include elements which are separated from a heated and/or mechanically cooled space by a vented air space. The gross area of a roof/ceiling assembly consists of the total interior surface of such assembly, including skylights ((~~exposed to the heated or mechanically cooled space~~)).

Guest room: See the Seattle Building Code.

Heat: The form of energy that is transferred by virtue of a temperature difference.

Heat storage capacity: The physical property of materials (mass) located inside the building envelope to absorb, store, and release heat.

Heat trap: A bent piece of tubing which forms a loop of 360 degrees; an arrangement of pipe fittings, such as elbows, connected so that the inlet and outlet piping make vertically upward runs just before turning downward to connect to the water heater's inlet and outlet fittings; a commercially available heat trap; or any other type which effectively restricts the natural tendency of hot water to rise in the vertical pipe during standby periods. When the water heater outlet is directly horizontal out of the tank or is piped with an elbow on the vertical outlet and then downward, this piping arrangement itself is effectively a heat trap, and a separate heat trap is not then needed.

((~~Heated slab: Slab-on-grade construction in which the heating elements or hot air distribution system is in contact with or placed within the slab or the subgrade.~~))

Heated space (Group R Occupancy): Space within a building which is provided with a positive heat supply. Finished living space within a basement with registers or heating devices designed to supply heat to a basement space shall automatically define that space as heated space (see "Positive heating supply").

Heated space (Other than Group R Occupancy): An enclosed space within a building that is heated by a heating system whose output capacity

(a) Exceeds 10 Btu/(h·ft^2) but which is not capable of maintaining a space dry-bulb temperature of more than 49 degrees F at design heating conditions (hereinafter referred to as a semi-heated space), or

(b) Is capable of maintaining a space dry-bulb temperature of 50 degrees F or more at design heating conditions.

HSPF - Heating season performance factor: The total heating output (in Btu) of a heat pump during its normal annual usage period for heating divided by the total (watt hour) electric power input during the same period, as determined by test procedures consistent with the U.S. Department of Energy "Test Procedure for Central Air Conditioners, Including Heat Pumps" published in the December 27, 1979, Federal Register, Vol 44, No. 24, IOCFR. 430. When specified in Btu per watt hour an HSPF of 6.826 is equivalent to a COP of 2.0.

Humidistat: A regulatory device, actuated by changes in humidity, used for automatic control of relative humidity.

HVAC: Heating, ventilating and air conditioning.

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

HVAC system components: HVAC system components provide, in one or more factory-assembled packages, means for chilling and/or heating water with controlled temperature for delivery to terminal units serving the conditioned spaces of the building. Types of HVAC system components include, but are not limited to, water chiller packages, reciprocating condensing units and water source (hydronic) heat pumps (see "HVAC system equipment").

HVAC system efficiency: See "Efficiency, HVAC system."

HVAC system equipment: HVAC system equipment provides, in one (single package) or more (split system) factory-assembled packages, means for air circulation, air cleaning, air cooling with controlled temperature and dehumidification; and optionally, either alone or in combination with a heating plant, the functions of heating and humidifying. The cooling function may be either electrically or heat operated and the refrigerant condenser may be air, water or evaporatively cooled. Where the equipment is provided in more than one package, the separate packages shall be designed by the manufacturer to be used together. The equipment may provide the heating function as a heat pump or by the use of electric or fossil-fuel-fired elements. (The word "equipment" used without modifying adjective may, in accordance with common industry usage, apply either to HVAC system equipment or HVAC system components.)

((~~Illumination: The density of the luminous flux incident on a surface; it is the quotient of the luminous flux by the area of the surface when the latter is uniformly illuminated.~~))

Indirectly conditioned space: An enclosed space within the building that is not a heated or cooled space, whose area weighted heat transfer coefficient to heated or cooled spaces exceeds that to the outdoors or to unconditioned spaces; or through which air from heated or cooled spaces is transferred at a rate exceeding three air changes per hour. Enclosed corriders between conditioned spaces shall be considered as indirectly conditioned space (see "Heated space", "Cooled space" and "Unconditioned space").

Infiltration: The uncontrolled inward air leakage through cracks and interstices in any building element and around windows and doors of a building caused by the pressure effects of wind and/or the effect of differences in the indoor and outdoor air density.

Insolation: The rate of solar energy incident on a unit area with a given orientation.

Insulation baffle: A rigid material, resistant to wind driven moisture, the purpose of which is to allow air to flow freely into the attic or crawl space and to prevent insulation from blocking the ventilation of these spaces, or the loss of insulation. Example materials for this purpose are sheet metal, or wax impregnated cardboard.

Integrated part-load value (IPLV): A single number figure of merit based on part-load EER or COP expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

Interior lighting power allowance (ILPA): The calculated maximum lighting power allowed for an interior space of a building or facility, in Watts.

((~~**Light loss factor (LLF):** A factor used in calculating the level of illumination after a given period of time and under given conditions. It takes into account temperature and voltage variations, dirt accumulation on luminaire and room surfaces, lamp depreciation, maintenance procedures and atmospheric conditions.~~))

Luminaire: A complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply.

Manual: Capable of being operated by personal intervention. As applied to an electric controller, nonautomatic control does not necessarily imply a manual controller but only that personal intervention is necessary (see "Automatic").

Marked rating: The design load operating conditions of a device as shown by the manufacturer on the nameplate or otherwise marked on the device.

Motor efficiency, nominal: The median efficiency occurring in a population of motors of the same manufacturer and rating.

((~~**Multifamily dwelling:** A building containing three or more dwelling units.~~))

Net Heat Output: The change in the total heat content of the air entering and leaving the equipment (not including supplementary heat and heat from boilers).

Net Heat Removal: The total heat content of the air entering and leaving the equipment (without heat) or the difference in total heat content of the water or refrigerant entering and leaving the component.

New energy: Energy, other than recovered energy, utilized for the purpose of heating or cooling (see "Energy").

Nominal R value: The thermal resistance of insulation as specified by the manufacturer according to recognized trade and engineering standards.

Nondepletable energy sources: See "Renewable energy sources."

Non-renewable energy sources: All energy sources that are not renewable energy sources including natural gas, oil, coal, wood, liquefied petroleum gas, steam, and any utility-supplied electricity (see "Renewable energy sources").

Occupancy: See the Seattle Building Code.

Occupancy sensor: A device that detects the presence or absence of people within an area and causes any combination of lighting, equipment, or appliances to be adjusted accordingly.

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

Open blown: Loose fill insulation pneumatically installed in an unconfined attic space.

Orientation: The directional placement of a building on a building site with reference to the building's longest horizontal axis, or if there is no longest horizontal axis then with reference to the designated main entrance.

Outdoor air: Air taken from the outdoors and, therefore, not previously circulated through the HVAC system of a building or structure.

((~~Overall thermal transfer value (OTTV): The thermal transfer into the building through its walls or roof due to solar heat gain and outdoor-indoor temperature differences as determined by Equations 3 and 4 (see Chapter 5).~~))

Packaged terminal air conditioner (PTAC): A factory-selected wall sleeve and separate unencased combination of heating and cooling components, assemblies or sections intended for mounting through the wall to serve a room or zone. It includes heating capability by hot water, steam, or electricity. (For the complete technical definition, see Standard RS-10 listed in Chapter 7.)

Packaged terminal heat pump: ((~~A factory-selected combination of heating and cooling components, assemblies or sections intended for application in a individual room or zone.~~)) A PTAC capable of using the refrigeration system in a reverse cycle or heat pump mode to provide heat. (For the complete technical definition, see Standard RS-21 listed in Chapter 7.)

Permeance (perm): The ability of a material of specified thickness to transmit moisture in terms of amount of moisture transmitted per unit time for a specified area and differential pressure (grains per hour·ft^2·in.HG). Permeance may be measured using ASTM E-96-72 or other approved dry cup method as specified in Standard RS-1 listed in Chapter 7.

Piping: A system for conveying fluids including pipes, valves, strainers, and fittings.

Plenum: An enclosure that is part of the air handling system and is distinguished by having a very low air velocity. A plenum often is formed in part or in total by portions of the building.

Pool cover: A vapor-retardant cover which lies on or at the surface of the pool.

Positive cooling supply: Mechanical cooling deliberately supplied to a space, such as through a supply register. Also, mechanical cooling indirectly supplied to a space through uninsulated surfaces of space cooling components, such as evaporator coil cases and cooling distribution systems which ((~~continually~~)) are capable of maintaining air temperatures within the space of 85 degrees F. or lower ((~~during normal operation~~)) at the exterior design conditions specified in Section 302.1. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of this code.

Positive heating supply: Heat deliberately supplied to a space by design, such as a supply register, radiator or heating

elements. Also, heat indirectly supplied to a space through uninsulated surfaces of service water heaters and space heating components, such as furnaces, boilers and heating and cooling distribution systems which ((~~continually~~)) are capable of maintaining air temperature within the space of 50 degrees F. or higher ((~~during normal operation~~)) at the exterior design conditions specified in Section 302.1. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of this code.

Power: In connection with machines, the time rate of doing work. In connection with the transmission of energy of all types, the rate at which energy is transmitted; in customary units, it is measured in watts (W) or British thermal units per hour (Btu/h).

Prescribed assumption: A fixed value of an input to the standard calculation procedure.

Process energy: Energy consumed in support of a manufacturing, industrial, or commercial process other than the maintenance of comfort and amenities for the occupants of a building.

Process load: The calculated or measured time-integrated load on a building resulting from the consumption or release of process energy.

Proposed design: A prospective design for a building that is to be evaluated for compliance.

Prototype building: A generic building design of the same size and occupancy type as the proposed design which complies with the requirements of this code and has prescribed assumptions used to generate the energy budget concerning shape, orientation, HVAC, and other system designs (see "Reference building").

Public facility rest room: A rest room used by the transient public on a regular (rather than casual) basis. Examples include rest rooms in service stations, airports, train terminals and convention halls. Rest rooms incorporated with private guest rooms in hotels, motels or dormitories and rest room facilities intended for the use of employees and not usually used by the general public are not considered public facility rest rooms.

Radiant slab: A slab on grade containing heating pipes, ducts, or electric heating cables that constitute a radiant slab or portion thereof for a complete or partial heating of the structure.

Readily accessible: ((~~Capable of being reached quickly for operation, renewal or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc (see "Accessible").~~)) See the Seattle Mechanical Code.

Recommend: Suggest as appropriate; not required.

Recooling: The removal of heat by sensible cooling of the supply air (directly or indirectly) that has been previously heated above the temperature to which the air is to be supplied to the conditioned space for proper control of the temperature of that space.

Recovered energy: Energy utilized which would otherwise be wasted (i.e., not contribute to a desired end use) from an energy utilization system.

Reference building: A specific building design that has the same form, orientation and basic systems as the proposed design and meets all the criteria of this code (see "Prototype building").

Reflectance: The ratio of the light reflected by a surface to the light falling upon it.

Reheat: The application of sensible heat to supply air that has been previously cooled below the temperature of the conditioned space by either mechanical refrigeration or the introduction of outdoor air in excess of that required by the Seattle Building Code and the Seattle Mechanical Code to provide cooling.

((~~Nondepletable~~)) **Renewable energy sources:** Sources of energy (excluding minerals) derived from incoming solar radiation, including natural daylighting and photosynthetic processes; from phenomena resulting therefrom, including wind, waves and tides, lake or pond thermal differences; and energy derived from the internal heat of the earth, including nocturnal thermal exchanges.

Reset: Adjustment of the set point of a control instrument to a higher or lower value automatically or manually to conserve energy.

Roof/ceiling assembly: See "Gross roof/ceiling area."

Room air conditioner: An encased assembly designed as a unit primarily for mounting in a window or through a wall, or as a console. It is designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone. It includes a prime source of refrigeration for cooling and dehumidification and means for circulating and cleaning air, and may also include means for ventilating and heating.

((~~Room cavity ratio (RCR): A number related to room dimensions used in average illumination calculations.~~))

Sash crack: The sum of all perimeters of all ventilators, sash, or doors based on overall dimensions of such parts expressed in feet (counting two adjacent lengths of perimeter as one).

Seasonal energy efficiency ratio (SEER): The total cooling output of an air conditioner during its normal annual usage period for cooling, in Btu, divided by the total electric energy input during the same period, in watt-hours, as determined by 10 CFR, Part 430.

Semi-heated space: See "Heated space."

Sequence: A consecutive series of operations.

Service systems: All energy-using or -distributing systems in a building that are operated to provide services for the occupants or processes housed therein, including HVAC, service water heating, illumination, transportation, cooking or food preparation, laundering or similar functions.

Service water heating: Supply of hot water for domestic or commercial purposes other than comfort heating.

Service water heating demand: The maximum design rate of energy withdrawal from service water heating system in a designated period of time (usually an hour or a day).

Shaded: Glazing area which is externally protected from direct solar radiation by use of devices permanently affixed to the structure or by an adjacent building, topographical feature or vegetation.

Shading coefficient (SC): The ratio of solar heat gain through fenestration, with or without integral shading devices, to that occurring through unshaded 1/8 in. thick clear double strength glass.

$$SC = \frac{\text{Solar Heat Gain of Fenestration}}{\text{Solar Heat Gain}}$$

Note: To be compared under the same conditions. See Chapter 26 of Standard RS-1 listed in Chapter 7.

Shall: Denotes a mandatory code requirement.

Should: Not mandatory but desirable as good practice.

Single family: One and two family residential dwelling units with no more than two units in a single building.

Skylight: A glazing surface that has a slope of less than 60 degrees from the horizontal plane.

Slab on grade exterior: Any portion of a slab floor in contact with the ground which is less than or equal to 24 inches below the final elevation of the nearest exterior grade.

Slab-below-grade: Any portion of a slab floor in contact with the ground which is more than 24 inches below the final elevation of the nearest exterior grade.

Solar energy source: Source of natural daylighting and of thermal, chemical or electrical energy derived directly from conversion of incident solar radiation.

Standard calculation procedure: An energy simulation model and a set of input assumptions that account for the dynamic thermal performance of the building; it produces estimates of annual energy consumption for heating, cooling, ventilation, lighting, and other uses.

Standard framing: All framing practices not defined as "intermediate" or "advanced" shall be considered standard (see "Advanced framed ceiling", "Advanced framed walls", and in Chapter 10, "Intermediate framed wall").

Substantial contact: A condition where adjacent building materials are placed in a manner that proximal surfaces are contiguous, being installed and supported as to eliminate voids between materials, without compressing or degrading the thermal performance or either product.

Substantially remodeled or rehabilitated: Any alteration or restoration of a building or structure within any 12 month period, the cost of which exceeds 60 percent of the current replacement value of the particular building or structure.

System: A combination of central or terminal equipment or components and/or controls, accessories, interconnecting means, and terminal devices by which energy is transformed so as to perform a specific function, such as HVAC, service water heating or illumination.

Tapering: Installation of a reduced level of ceiling insulation at the eaves, due to reduced clearance.

Terminal element: The means by which the the transformed energy from a system is finally delivered; i.e., registers, diffusers, lighting fixtures, faucets and similar elements.

Thermal by-pass: An area where the envelope surrounding the conditioned space is breached, or where an ineffective application compromises the performance of a thermal or infiltration barrier, increasing the structure's energy consumption by exposing finished surfaces to ambient conditions and additional heat transfer.

Thermal conductance: Time rate of heat flow through a body (frequently per unit area) from one of its bounding surfaces to the other for a unit temperature difference between the two surfaces, under steady conditions ($Btu/h \cdot ft^2 \cdot °F.$).

Thermal mass: Materials with mass heat capacity and surface area capable of affecting building loads by storing and releasing heat as the interior and/or exterior temperature and radiant conditions fluctuate (see "Wall heat capacity").

Thermal mass wall insulation position:

(a) **exterior insulation position:** a wall having all or nearly all of its mass exposed to the room air with the insulation on the exterior of that mass.

(b) **integral insulation position:** a wall having mass exposed to both room and outside air with substantially equal amounts of mass on the inside and outside of the insulation layer.

(c) **interior insulation position:** a wall not meeting either of the above definitions, particularly a wall having most of its mass external to an insulation layer.

Thermal resistance (R): The reciprocal of thermal conductance ($h \cdot ft^2 \cdot °F./Btu$).

Thermal transmittance (U): The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature different between the warm side and cold side air films ($Btu/h \cdot ft^2 \cdot °F.$). ((~~The U value applies to combinations of different materials used in series along the heat flow path, single materials that comprise a building section, cavity air spaces and surface air films on both sides of a building element.~~)) (See Section 502 and Standard RS-1 for the different calculation procedures.)

Thermal transmittance, overall (U_o): The overall (average) heat tranmission of a gross area of the exterior building envelope (Btu/h·ft^2·°F.) The U_o value applies to the combined effect of the time rate of heat flows through the various parallel paths, such as windows, doors and opaque construction areas, comprising the gross area of one or more exterior building components, such as walls, floors or roof/ceilings.

Thermostat: An automatic control device actuated by temperature and designed to be responsive to temperature.

Total lighting power allowance: The calculated lighting power allowed for the interior and exterior space areas of a building or facility.

Total on-site energy input: The combination of all the energy inputs to all elements and accessories as included in the equipment components, including but not limited to, compressor(s), compressor sump heater(s), circulating pump(s), purge devices, fan(s), and the HVAC system component control circuit.

Transmission coefficient: The ratio of the solar heat gain through a glazing system to that of an unshaded single pane of double strength window glass under the same set of conditions.

Unconditioned space: Space within a building that is not a conditioned space (see "Conditioned space").

Unit lighting power allowance (ULPA): The allotted lighting power for each individual building space in W/ft^2.

Unitary cooling and heating equipment: One or more factory-made assemblies which include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well. Where such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

Unitary heat pump: One or more factory-made assemblies which include an indoor conditioning coil, compressor(s) and outdoor coil or refrigerant-to-water heat exchanger, including means to provide both heating and cooling functions. When such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

Vapor retarder: A layer of low moisture transmissivity material (not more than 1.0 perm dry cup) placed over the warm side (in winter) of insulation, over the exterior of below grade walls, and under floors as ground cover to limit the transport of water and water vapor through exterior walls, ceilings, and floors. Vapor retarding paint, listed for this application, also complies with this code.

Variable air volume (VAV) HVAC system: HVAC systems that control the dry-bulb temperature within a space by varying the volume of supply air to the space.

Vaulted ceilings: All ceilings where enclosed joist or rafter space is formed by ceilings applied directly to the underside of roof joists or rafters.

((~~Veiling reflections: Regular reflections superimposed upon diffuse reflections from an object that partially or totally obscure the details to be seen by reducing the contrast. This is sometimes called reflected glare.~~))

Ventilation: The process of supplying or removing air by natural or mechanical means to or from any space. Such air may or may not have been conditioned.

Ventilation air: That portion of supply air which comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space. (See ((~~Standard RS-3 listed in Chapter 7, Chapter 3 of this code and~~)) definition of "Outdoor air", the Seattle Building Code and the Seattle Mechanical Code.)

Walls (exterior): Any member of group of members which defines the exterior boundaries or courts of a building and which have a slope of 60 degrees or greater with the horizontal plane, and separates conditioned from unconditioned space. Band joists between floors are to be considered a part of exterior walls (see "Roof/ceiling assembly").

Wall heat capacity: The sum of the products of the mass of each individual material in the wall per unit area of wall surface times its individual specific heat, Btu/ft^2·°F (see "Thermal mass").

Water-chilling package of absorption: A factory-designed and prefabricated assembly (not necessarily shipped as a single package) of one or more condensers, evaporators (water coolers), absorbers and generators with interconnections and accessories used for chilling water.

Water-chilling package, centrifugal or rotary: A factory-designed and prefabricated assembly (not necessarily shipped as one package) of one or more centrifugal or rotary compressors, condensers and water coolers (evaporators) with interconnections and accessories used for chilling water.

Water-chilling package, reciprocating: A factory-designed and prefabricated assembly, self-contained or condenserless, of one or more reciprocating compressors, condensers (self-contained only), water coolers (evaporator) and interconnections and accessories used for chilling water. The condenser may be air, evaporatively or water cooled.

Watt (W): A unit of power. One watt is produced when one ampere, flows at an emf of one volt (unity power factor) (see "Power").

((~~Work plane: The plane at which work is usually done and at which the illumination is specified and measured. Unless otherwise indicated, this is assumed to be a horizontal plane 30 inches above the floor.~~))

Zone: A space or group of spaces within a building with heating and/or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device. Each dwelling unit in residential buildings shall be considered a single zone.

Section 11: As of July 1, 1991, a new Section 202 is added to the 1989 Model Energy Code as follows:

SECTION 202 - ABBREVIATIONS, ACRONYMS AND SYMBOLS

A	area
A_{bgw}	area of below grade wall
A_{cc}	area of cathedral ceiling
A_d	area of opaque door
A_f	area of floor over unconditioned space
A_g	area of glazing
A_{rc}	area of roof ceiling
A_w	area of opaque wall
AAMA	American Architectural Manufacturers Association
AFUE	annual fuel utilization efficiency
AHAM	Association of Home Appliance Manufacturers
AIA	American Institute of Architects
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BECON	budget energy consumption
Btu/h	British thermal unit per hour
C	thermal conductance
CFM	cubic feet per minute
COP	coefficient of performance
D	density in lbs./cu.ft.
DECON	design energy consumption
DOE	U. S. Department of Energy
EER	energy efficiency ratio
ELPA	exterior lighting power allowance
F_s	F-value for slab on grade floor
GFA	gross building floor area
Hc	heat capacity
hp	horsepower
HS	heat storage
HSPF	heating seasonal performance factor
HVAC	heating, ventilating and air conditioning
IES	Illuminating Engineering Society of North America
ILPA	interior lighting power allowance
IPLV	integrated part load value
K	insulation value of a material per inch
n	fraction of year when outdoor daily mean temperature exceeds 64.9 degrees F.
NFPA	National Fire Protection Association
pmd	probable maximum demand in gallons per hour
P_s	perimeter of slab on grade floor in lineal feet
PR	pipe actual outside radius in inches
PTAC	packaged terminal air-conditioner
r	thermal resistivity
R	thermal resistance
r_i	thermal resistance of inside air film
r_o	thermal resistance of outside air film
SC	shading coefficient
SEER	seasonal energy efficiency ratio
SH	specific heat of a material

SWH	service water heating
t	temperature in degrees F.
th	insulation thickness in inches
TEFC	totally enclosed, fan cooled
U	thermal transmittance
U_{bgw}	thermal transmittance of below grade wall
U_{cc}	thermal transmittance of cathedral ceiling assembly
U_d	thermal transmittance of opaque door
U_f	thermal transmittance of floor over unconditioned space assembly
U_g	thermal transmittance of glazing
U_o	overall thermal transmittance
U_{rc}	thermal transmittance of roof ceiling assembly
U_w	thermal transmittance of opaque wall
UA_p	proposed combined thermal transmittance
UA_t	target combined thermal transmittance
UFA	usable floor area
ULPA	unit lighting power allowance
VAV	variable air volume
VLT	transmittance of glazing material over visible portion of solar spectrum
W	watts
WC	water column
X	thickness of a material in inches

Section 12: As of July 1, 1991, Section 302 of the 1989 Model Energy Code is amended as follows:

SECTION 302 - THERMAL DESIGN PARAMETERS

302.1 Exterior design conditions: The following design parameters shall be used for calculations required under this code.

EXTERIOR DESIGN CONDITIONS

WINTER ((~~1~~))	Design Dry-bulb	24°F.
SUMMER ((~~1~~))	Design Dry-bulb	82°F.
	Design Wet-bulb	66°F.
DEGREE DAYS HEATING		4800
DEGREES NORTH LATITUDE		48

((~~1 The outdoor design temperature shall be selected from the columns of 97.5 percent values for winter and 2.5 percent values for summer from tables in Standard RS-1 listed in Chapter 7. Adjustments may be made to reflect local climates which differ from the tabulated temperatures, or local weather experience as determined by the building official.~~))

302.2 Interior design conditions

302.2.1 Indoor design temperature. Indoor design temperature shall be ((~~72~~)) 70 degrees F. for heating and 78 degrees F. for cooling.

Exception: Other design temperatures may be used for equipment selection if it results in a lower energy usage.

302.2.2 Humidification: If humidification is provided during heating, it shall be designed for a maximum relative humidity of 30 percent. When comfort air conditioning is provided, the actual design relative humidity within the comfort envelope as defined in Standard RS-4 listed in Chapter 7 shall be selected for minimum total HVAC system energy use.

Section 13: As of July 1, 1991, Section 303 of the 1989 Model Energy Code is amended as follows:

SECTION 303 - MECHANICAL VENTILATION CRITERIA

303.1 Ventilation: See the requirements in the Seattle Building Code and the Seattle Mechanical Code. ((~~Ventilation air shall conform to Standard RS-3 listed in Chapter 7. The minimum column value of Standard RS-3 for each type of occupancy shall be used for design. The ventilation quantities specified in Section 6 of Standard RS-3 are for 100 percent outdoor air ventilating systems. Section 5 of Standard RS-3 permits a reduction to 33 percent of the specified minimum outdoor air requirements for recirculating HVAC systems.~~

~~Exception:~~ ~~If outdoor air quantities other than those specified in Standard RS-3 are used or required because of special occupancy or process requirements, source control of air contamination, health and safety or other standards, the required outdoor air quantities shall be used as the basis for calculating the heating and cooling design loads.~~))

Section 14: As of July 1, 1991, the heading of Chapter 4 of the 1989 Model Energy Code is amended as follows:

CHAPTER 4
BUILDING DESIGN BY SYSTEMS ANALYSIS
((~~AND DESIGN OF BUILDINGS UTILIZING NONDEPLETABLE ENERGY SOURCES~~))

Section 15: As of July 1, 1991, Section 401 of the 1989 Model Energy Code is amended as follows:

SECTION 401 - SCOPE

401.1 General: This chapter establishes design criteria in terms of total on-site energy use by a building, including all of its systems. Analysis of design for all Group R Occupancy shall comply with Sections 402.1 to 402.6. The key Group R Occupancy requirements are in Section 402.6. Analysis of design for other buildings shall comply with Sections 402.1 to 402.5.

The building permit application for projects utilizing this chapter shall include in one submittal all building and mechanical drawings and information necessary to verify that the design for the project corresponds with the annual energy analysis.

Due to the various assumptions that are necessary, the results of the analysis shall not be construed as a guarantee of the actual energy performance of the project.

Section 16: As of July 1, 1991, Section 402 of the 1989 Model Energy Code is amended as follows:

SECTION 402 - SYSTEMS ANALYSIS

402.1 Energy analysis: Compliance with this chapter will require an analysis of the annual energy usage, hereinafter called an annual energy analysis.

Exception: Chapter((~~s~~)) 5 ((~~and 6~~)) of this code establishes criteria for different energy-consuming and enclosure elements of the building which, if followed, will eliminate the requirement for an annual energy analysis while meeting the intent of this code.

A building designed in accordance with this chapter will be deemed as complying with this code if the calculated annual energy consumption is not greater than a similar building (defined as a "standard, reference or prototype, design" and defined in Section 402.1) whose enclosure elements and energy-consuming systems are designed in accordance with Chapter 5 and the reference or prototype design building as defined in Chapter 9. However, building projects shall only be exempted from those requirements in Chapter 5 which have been accurately and completely modeled. Where variations from the Chapter 5 requirements are not specifically analyzed, the building shall be designed in accordance with Chapter 5, including control requirements.

For an alternate building design to be considered similar to a "standard, reference or prototype, design," it shall utilize the same energy source(s) for the same functions and have equal floor area and the same ratio of envelope area to floor area, environmental requirements, occupancy, climate data and usage operational schedule. Inputs to the energy analysis relating to occupancy and usage shall correspond to the expected occupancy and usage of the building.

Except as noted below, the systems identified, and, to the extent possible, the assumptions made in assigning energy inputs to each system, shall be the same for the standard design and the proposed alternative design. When electrically driven heat pumps, other than multiple units connected to a common water loop, are employed to provide all or part of the heat for the alternative design, the standard design shall also, for the purposes of the analysis, assume that electrically driven heat pumps in conformance with Section 503 and having capacity at least as great as those used in the alternative design are employed.

402.2 Design: The standard, reference or prototype, design, conforming to the criteria of Chapter 5 ((~~or Chapter 6~~)) and the proposed alternative design shall be designed on a common basis as specified herein:

- The comparison shall be expressed as Btu input per square foot of gross floor area per year at building site.

- If the proposed alternative design results in an increase in consumption of one energy source and a decrease in another energy source, even though similar sources are used for similar purposes, the difference in each energy source shall be converted to equivalent energy units for purposes of comparing the total energy used. If energy consumption for heating provided by natural gas or oil increases because of a decrease in lighting or other electrical internal loads, the amount of additional natural gas or oil energy required shall be multiplied by the combustion efficiency given in Table No. 5-6 as part of the conversion into equivalent energy units.

402.3 Analysis procedure: The analysis of the annual energy usage of the standard, reference or prototype, and the proposed alternative building and system design shall meet the following criteria:

- The building heating/cooling load calculation procedure used for annual energy consumption analysis shall be detailed to permit the evaluation of effect of factors specified in Section 402.4.

- The calculation procedure used to simulate the operation of the building and its service systems through a full-year operating period shall be detailed to permit the evaluation of the effect of system design, climatic factors, operational characteristics, and mechanical equipment on annual energy usage. Manufacturer's data or comparable field test data shall be used when available in the simulation of systems and equipment. The calculation procedure shall be based upon 8760 hours of operation of the building and its service systems and shall utilize the design methods specified in Standards RS-1, -11, -12 and -13 listed in Chapter 7, or on other programs approved by the building official.

402.4 Calculation procedure: The calculation procedure shall cover the following items:

- Design requirements--Environmental requirements as required in Chapter 3.

- Climatic data--Coincident hourly data for temperatures, solar radiation, wind and humidity of typical days in the year representing seasonal variation.

- Building data--Orientation, size, shape, mass, air moisture and heat transfer characteristics.

- Operational characteristics--Temperature, humidity, ventilation, illumination, control mode for occupied and unoccupied hours.

- Mechanical equipment--Design capacity, part load profile.

° Building loads--Internal heat generation, lighting, equipment, number of people during occupied and unoccupied periods.

Exception: Group R Occupancy shall comply with the calculation procedures in Chapter 8, or an approved alternate.

402.5 Documentation: ((~~Proposed alternative designs, submitted as requests for exception to the standard design criteria,~~)) All analysis submitted shall be accompanied by three copies of an energy analysis comparison report. The report shall provide technical detail on the two building and system designs and on the data used in and resulting from the comparative analysis to verify that both the analysis and the designs meet the criteria of Chapter 4 of this code.

The calculation procedure for the standard, reference or prototype, design and the proposed design shall separately identify the calculated annual energy consumption, for each different occupancy type if possible, for each of the following end uses:

° Interior lighting;

° Parking lighting;

° Exterior lighting;

° Space heating;

° Space cooling;

° Interior ventilation/fans;

° Parking ventilation/fans;

° Exhaust fans;

° Service water heating;

° Elevators;

° Appliances.

Energy consumption of the following items shall be included but is not required to be separated out by each individual item.

° Office equipment;

° Refrigeration other than comfort cooling;

° Cooking; and

° Any other energy-consuming equipment.

The specifications of the proposed building project used in the analysis shall be as similar as is reasonably practical to those in the plans submitted for a building permit.

Exception: Proposed alternative designs for one- and two-family dwellings, multifamily buildings, other Group R Occupancy and for commercial and industrial structures having an area of 25,000 square feet or less ((~~having the indoor temperature controlled from a single point~~)) are exempted from

the full-year energy analysis described in the second paragraph of 402.3. However, comparison of energy consumption between the alternative design and the standard design shall be provided based on the ASHRAE TC4.7 simplified energy analysis procedure using the modified bin method or equivalent.

402.6 Special requirements for all Group R Occupancy

402.6.1 Energy budgets: Proposed buildings designed in accordance with this section shall be designed to use no more energy from non-renewable sources for space heating, and domestic hot water heating than a standard building whose enclosure elements and energy consuming systems are designed in accordance with Section 502.2 of this code for the appropriate heating system type. Energy derived from renewable sources may be excluded from the total annual energy consumption attributed to the alternative building.

402.6.2 Calculation of energy consumption: The application for a building permit shall include documentation which demonstrates, using calculation procedure as listed in Chapter 8, or an approved alternate, that the proposed building's annual space heating energy use does not exceed the annual space heating and water heating energy use of a standard building conforming to Chapter 5 of this code. The total calculated annual energy consumption shall be shown in units of $kWh/ft^2/year$ or $Btu/ft^2/year$ of conditioned area.

402.6.3 Input values: The following standardized input values shall be used in calculating annual space heating budgets:

PARAMETER	**VALUE**
Thermostat set point, heating	65°F
Thermostat set point, cooling	78°F
Thermostat night set back	65°F
Thermostat night set back period	0 hours
Internal Gain	
R-3 units	3000 Btu/hr
R-1 units	1500 Btu/hr
Domestic Hot Water Heater Setpoint	120°F
Domestic Hot Water Consumption	20 gallons/person/day.
Minimum Heat Storage	Calculated using standard engineering practice for the actual building or as approved.
Site Weather Data	Typical meteorological year (TMY) or ersatz TMY data for the closest appropriate TMY site or other sites as approved.
Heating Equipment Efficiency	

Electric resistance heat	1.00
Heat Pumps	6.80 HSPF.
Other Fuels	0.78 AFUE.

The standard building shall be modeled with glazing area distributed equally among the four cardinal directions. Parameter values that may be varied by the building designer to model energy saving options include, but are not limited to, the following:

1. Overall thermal transmittance, U_o, of building envelope or individual building components.

2. Heat storage capacity of building;

3. Glazing orientation; area; and shading coefficients;

4. Heating system efficiency;

402.6.4 Solar shading and access: Building designs using passive solar features with 8 percent or more south facing equivalent glazing to qualify shall provide to the building official a sun chart or other approved documentation depicting actual site shading for use in calculating compliance under this section. The building shall contain at least 45 Btu/°F for each square foot of south facing glass.

402.6.5 Infiltration: Infiltration levels used shall be set at 0.35 air changes per hour for thermal calculation purposes only.

402.6.6 Heat pumps: The heating season performance factor (HSPF) for heat pumps shall be calculated using procedures consistent with Section 5.2 of the U.S. Department of Energy Test Procedure for Central Air Conditioners, including heat pumps published in the December 27, 1979 Federal Register Vol. 44, No. 24.10 CFR 430. Climate data as specified above, the proposed buildings overall thermal performance value (Btu/°F) and the standardized input assumptions specified above shall be used to model the heat pumps HSPF.

Section 17: As of July 1, 1991, Section 403 of the 1989 Model Energy Code is hereby repealed.

Section 18: As of July 1, 1991, the heading of Chapter 5 of the 1989 Model Energy Code is amended as follows:

CHAPTER 5
BUILDING DESIGN BY PRESCRIPTIVE/COMPONENT PERFORMANCE APPROACH

Section 19: As of July 1, 1991, Section 502 of the 1989 Model Energy Code is amended, Table Nos. 502.1.2.a, 502.1.2b, 502.1.2c, 502.2.1 and 502.4.2 and Equations 1-4 are deleted and

new Table Nos. 5-1, 5-2, 6-1, 6-2, 6-5 and 6-6 and Equations 1-5 are added as follows:

SECTION 502 - BUILDING ENVELOPE REQUIREMENTS

502.1 General: The envelope design of an evaluated building is in compliance with the requirements of this section when:

(a) Compliance is achieved with the basic requirements and required calculation procedures of Sections 502.1 and 502.4 and

(b) Compliance is achieved with the criteria of one of the following alternate compliance paths:

1. Target UA criteria of Sections 502.2.1 and 502.3.1 using the equations given, or for the gross exterior wall area in Section 502.3.1, using the ENVSTD diskette version 2.1 or 2.2 from ASHRAE/IES Standard 90.1.

2. Prescriptive criteria of Sections 502.2.2 and 502.3.2.

502.1.1: The stated U_o or F value of any component assembly, listed in Table No. 5-1 or 5-2, such as roof/ceiling, opaque wall or opaque floor may be increased and the U_o value for other components decreased, provided that the total heat gain or loss for the entire building envelope does not exceed the total resulting from ((~~conformance~~)) compliance to the U_o values specified in ((~~Table Nos. 502.2.1 and 502.3.1~~)) this section. ((~~For Group R buildings regulated by Section 502.2, Figure No. 13 of Chapter 7 may be used to determine a lower U_o value for the roof/ceiling assembly when the U_o value of the wall does not conform to the U_o value specified in Table No. 502.2.1.~~))

The U-values for typical construction assemblies are included in Chapter 10. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Chapter 10, values shall be calculated in accordance with Chapters 19-27 in Standard RS-1 listed in Chapter 7, using the framing factors listed in Chapter 10.

For envelope assemblies containing metal framing, the U-value shall be determined by one of the following methods:

1. Results of laboratory or field measurements.

2. Standard RS-25 listed in Chapter 7 where the metal framing is bonded on one or both sides to a metal skin or covering.

3. The zone method as provided in Chapter 22 of Standard RS-1 listed in Chapter 7.

4. Effective framing/cavity R-values as provided from the following table for metal stud walls:

WALL FRAMING	CAVITY INSULATION	
	R-11	R-19
2 x 4 @ 16" o.c.	5.50	-
2 x 4 @ 24" o.c.	6.60	-
2 x 6 @ 16" o.c.	-	7.60
2 x 6 @ 24" o.c.	-	8.55

502.1.2: The proposed design may take into account the thermal mass of the building components in considering energy conservation in accordance with Sections 402 and 502.3. ((~~For residential buildings the required U_w for exterior walls, other than basement and crawl space walls, having a heat capacity greater than or equal to 6.7 Btu/ft.^{2}·°F., shall be less than or equal to the values in Table Nos. 502.1.2a, 502.1.2b, or 502.1.2c. The values in Table Nos. 502.1.2a, 502.1.2b, or 502.1.2c are functions of the heating degree days at the building location and the U_w determined by using Equation 1.~~

~~Masonry or concrete walls having a weight greater than or equal to 30 lb./ft.^{2} and solid wood walls having a weight greater than or equal to 20 lb./ft.^{2} have heat capacities equal or exceeding 6 Btu/ft.^{2}·°F.~~

~~For other wall construction, the heat capacity of the wall shall be determined by using HC = w x c where:~~

~~HC = heat capacity of the wall, Btu/ft.^{2}·°F.~~

~~w = weight of the wall, lb./ft.^{2}~~

~~c = specific heat of the wall, Btu/lb·°F.~~

~~The specific heat values may be obtained from Chapter 23 of Standard RS-1 listed in Chapter 7.~~))

(Table Nos. 502.1.2a, 502.1.2b and 502.1.2c are deleted.)

502.1.3: When return air ceiling plenums are employed, the roof/ceiling assembly shall:

- For thermal transmittance purposes, not include the ceiling proper nor the plenum space as part of the assembly; and,
- For gross area purposes, be based upon the interior face of the upper plenum surface.

502.1.4 Insulation

502.1.4.1 General: All insulating materials shall comply with Sections 1712 and 1713 of the Seattle Building Code. Substantial contact of the insulation with the surface being insulated is required. All insulation materials shall be installed according to the manufacturer's instructions to achieve proper densities, and maintain uniform R-values. To the maximum extent possible, insulation shall extend over the full component area to the intended R-value.

502.1.4.2 Insulation materials: All insulation materials including facings such as vapor barriers or breather papers installed within floor/ceiling assemblies, roof/ceiling assemblies, walls, crawl spaces, or attics shall have a flame-spread rating of less than 25 and a smoke density not to exceed 450 when tested in accordance with UBC Standard No. 42-1.

Exceptions

1. Foam plastic insulation shall comply with Section 1712 of the Seattle Building Code.

2. When such materials are installed in concealed spaces of Types III, IV and V construction, the flame-spread and smoke-developed limitations do not apply to facing, provided that the facing is installed in substantial contact with the unexposed surface of the ceiling, floor or wall finish.

3. Cellulose insulation shall conform to Section 1713 of the Seattle Building Code.

502.1.4.3 Clearances: Where required, insulation shall be installed with clearances according to manufacturers specifications. Insulation shall be installed so that required ventilation is unobstructed. For blown or poured loose fill insulation clearances shall be maintained through installation of a permanent retainer.

502.1.4.4 Access hatches and doors: Access doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces) shall be weatherstripped and insulated to a level equivalent to the insulation on the surrounding surfaces. Access shall be provided to all equipment which prevents damaging or compressing the insulation. A wood framed or equivalent baffle or retainer must be provided when loose fill insulation is installed, the purpose of which is to prevent the loose fill insulation from spilling into the living space when the attic access is opened, and to provide a permanent means of maintaining the installed R-value of the loose fill insulation.

502.1.4.5 Roof/ceiling insulation: Open-blown or poured loose fill insulation may be used in attic spaces where the slope of the ceiling is not more than 3 feet in 12 feet and there is at least 30 inches of clear distance from the top of the bottom chord of the truss or ceiling joist to the underside of the roof sheathing at the roof ridge. When eave vents are installed, baffling of the vent openings shall be provided so as to deflect the incoming air above the surface of the insulation. Baffles shall be rigid material, resistant to wind driven moisture. Requirements for baffles for ceiling insulation shall meet the Seattle Building Code Section 3205(c) for minimum ventilation requirements. When feasible, the baffles shall be installed from the top of the outside of the exterior wall, extending inward, to a point 6 inches vertically above the height of non-compressed insulation, and 12 inches vertically above loose fill insulation.

502.1.4.6 Wall insulation: Insulation installed in exterior walls shall comply with the provisions of this section. All wall insulation shall fill the entire cavity. Exterior wall cavities isolated during framing shall be fully insulated to the levels of the surrounding walls. All faced insulation shall be face stapled to avoid compression.

502.1.4.7 Floor Insulation: Floor insulation shall be installed in a permanent manner in substantial contact with the surface being insulated. Insulation supports shall be installed so spacing is no more than 24 inches on center. Foundation vents shall be placed so that the top of the vent is below the lower surface of the floor insulation.

Exception: Insulation may be omitted from floor areas over heated basements, heated garages, or underfloor areas used as HVAC supply plenums. See Seattle Mechanical Code Section 1008 for underfloor supply plenum requirements. When foundation walls are insulated, the insulation shall be attached in a permanent manner. The insulation shall not block the airflow through foundation vents when installed. When foundation vents are not placed so that the top of the vent is below the lower surface of the floor insulation, a permanently attached baffle shall be installed at an angle of 30 degrees from horizontal, to divert air flow below the lower surface of the floor insulation.

502.1.4.8 Slab-on-grade: Slab-on-grade insulation installed inside the foundation wall, shall extend downward from the top of the slab for a minimum distance of 24 inches or downward and then horizontally beneath the slab for minimum combined distance of 24 inches. Insulation installed outside the foundation shall extend downward to a minimum of 24 inches or to the frostline. Above grade insulation shall be protected.

Exception: For monolithic slabs, the insulation shall extend downward from the top of the slab to the bottom of the footing.

502.1.4.9 Radiant slabs: The entire area of a radiant slab shall be thermally isolated from the soil, with a minimum of R-10 insulation. The insulation shall be an approved product for its intended use. If a soil gas control system is present below the radiant slab, which results in increased convective flow below the radiant slab, the radiant slab shall be thermally isolated from the sub-slab gravel layer.

502.1.4.10 Below-grade walls:

1. Below grade exterior wall insulation used on the exterior (cold) side of the wall shall extend from the top of the below-grade wall to the top of the footing and shall be approved for below-grade use. Above grade insulation shall be protected.

2. Insulation used on the interior (warm) side of the wall shall extend from the top of the below-grade wall to the below-grade floor level.

502.1.5 Glazing and door U-values: For Group R Occupancy, glazing and door U-values shall be determined in accordance with Section 502.1.5.1. For other occupancies, glazing and door U-values shall be determined in accordance with either Section 502.1.5.1 or 502.1.5.2.

502.1.5.1 Standard procedure for determination of glazing and door U-values: U-values for glazing and doors, including all fire doors, shall be the tested U-values for thermal transmittance due to conduction resulting from either the AAMA 1503.1-88 test procedure or the ASTM C236-87 or C976-82 test procedures, provided that testing shall be conducted under established winter horizontal heat flow test conditions using fifteen mile per hour wind speed directed perpendicular to the exterior surface of the glazing as specified under AAMA 1503.1-88.

AAMA 1503.1-88 testing, shall be conducted by a laboratory accredited by AAMA to perform that test. ASTM C236-87 or C976-82

testing shall be conducted by an independent laboratory accredited by a nationally recognized accreditation program, independent of that laboratory. All tested U-values reported for listing by the State Building Code Council after January 1, 1991, shall include certification by the manufacturer of gas content in the sealed insulated glass unit used for testing and in the production unit.

Product samples tested shall be production line units or representative of units as purchased by the consumer or contractor. Product sample sizes tested shall be in accordance with AAMA 1503.1-88, except that skylights shall be tested with a nominal two foot by four foot size, or a nominal four foot by four foot size. The installation of the test sample shall be in accordance with AAMA 1503.1-88, Section 8.4. All testing performed after January 1, 1991 shall not include screens. All glazing and doors shall be identified with a label that states an overall product U-value that is no less than the actual tested U-value. The labeled U-value shall be used in all calculations to determine compliance with this code. Sealed insulating glass shall conform to, or be in test for, ASTM E-774-81 level A.

Exceptions

1. The exterior frame dimensions of the product sample size tested shall not deviate by more than three inches from the height and width specified, except that skylights are allowed to be tested in the closest production line size to that specified above.

2. Passive air inlets are not required to be part of the tested assembly.

3. Products tested prior to December 31, 1990, to AAMA 1503.1-80, ASTM C236-80 or C976-82 which are not in compliance with the test size requirement above, and which are in compliance with the product sample sizes in AAMA 1503.1-80, shall be acceptable until December 31, 1994.

4. Untested glazing and doors shall be assigned the default U-values listed in Chapter 10. The default values for the opaque portions of doors shall be those listed in Chapter 10, provided that the U-value listed for a door with a thermal break shall only be allowed if both the door and the frame have a thermal break.

5. The U-value of an insulated glazing product which has a `grille pattern' installed between the glazing layers shall be deemed equal to the U-value of an insulated glazing product which is tested without a `grille pattern' in between glazing layers, provided a minimum 1/8 inch air space exists between the `grille pattern' and both glass lites.

6. For a glazing product which is manufactured with an alternative `low-e coating' than the `low-e coating' of the tested glazing product, the U-value shall be deemed equal provided that the alternative `low-e coating' material has an equal or lower rated emissivity.

502.1.5.2 Alternate glazing and door U-values for Other than Group R Occupancy: Glazing U-values for Other than Group R Occupancy are also allowed to be taken from Table 13 of Chapter 27 of Standard RS-1 listed in Chapter 7 or calculated in

accordance with the procedures of Chapter 27 of Standard RS-1 listed in Chapter 7 and door U-values are also allowed to be taken from Table 6 in Chapter 22 of Standard RS-1 listed in Chapter 7.

502.1.6 Moisture control

502.1.6.1: Vapor retarders shall be installed on the warm side (in winter) of insulation as specified in the following cases.

Exception: Vapor retarder installed with not more than 1/3 of the nominal R-value between it and the conditioned space.

502.1.6.2 Floors: Floors separating conditioned space from unconditioned space shall have a vapor retarder installed. The vapor retarder shall have a one perm dry cup rating or less (i.e., 4 mil. polyethylene or kraft faced material).

502.1.6.3: Roof/ceiling assemblies where the ventilation space above the insulation is less than an average of twelve (12) inches shall be provided with a vapor retarder. Faced batt insulation where used as a vapor retarder shall be face stapled. Single rafter joist vaulted ceiling cavities shall be of sufficient depth to allow a minimum one inch vented air space above the insulation.

502.1.6.4: Vapor retarders shall not be required in roof/ceiling assemblies where the ventilation space above the insulation averages twelve (12) inches or greater.

502.1.6.5: Vapor retarders shall not be required where all of the insulation is installed between the roof membrane and the structural roof deck.

502.1.6.6 Wall insulation: Walls separating conditioned space from unconditioned space shall have a vapor retarder installed. Faced batt insulation shall be face stapled.

502.1.6.7 Ground cover: A ground cover of 6 mil (0.006 inch thick) black polyethylene or approved equal shall be laid over the ground within crawl spaces. The ground cover shall be overlapped twelve (12) inches minimum at the joints and shall extend to the foundation wall.

Exception: The ground cover may be omitted in unheated crawl spaces if the crawl space has a concrete slab floor with a minimum thickness of 3-1/2 inches.

502.2 Criteria for Group R Occupancy ((~~residential buildings~~)): Compliance with the building envelope requirements of this code shall be demonstrated by using the Target UA Approach in Section 502.2.1 or the Prescriptive Approach in Section 502.2.2.

For the purposes of this code, Group R Occupancy residential buildings shall ((~~include:~~)) be subdivided by space heating system type. The following two categories comprise all space heating types:

- Electric resistance: Space heating systems which include baseboard units, radiant units, and forced air units as either the primary or secondary heating system.

Exception: Electric resistance systems for which the total electric heat capacity in each individual dwelling unit does not exceed the greater of: 1) 1,000 watts per dwelling unit, or; 2) 1.0 watt per square foot of the gross floor area.

° Other: All gas, wood, oil, and propane space heating systems, unless electric resistance is used as a secondary heating system, and all heat pump space heating systems. (See Exceptions, Electric Resistance, above.)

((° ~~Type A-1 -- Detached one- and two-family dwellings; and~~

° ~~Type A-2 -- All other residential buildings, three stories or less in height.~~

~~502.2.1 Heating and cooling criteria~~

~~502.2.1.1 Walls: A residential building as herein defined that is heated or mechanically cooled shall have a combined thermal transmittance value (U_o) of the gross area of exterior walls not exceeding the value given in Table No. 502.2.1. Equation 1 shall be used to determine acceptable combinations to meet this requirement.~~

~~502.2.1.2 Roof/ceiling: A building that is heated and/or mechanically cooled shall have a combined thermal transmittance value (U_o) for the gross area of the roof assembly not exceeding the value given in Table No. 502.2.1. Equation 2 shall be used to determine acceptable combinations to meet this requirement.~~

~~502.2.1.3 Floors over unheated spaces: For floors of heated or mechanically cooled spaces over unheated spaces, the U_o value shall not exceed the value given in Table No. 502.2.1. For floors over outdoor air, i.e., overhangs, U_o values for heating shall meet the same requirements as shown for roofs in Table No. 502.2.1.~~

~~502.2.1.4 Slab-on-grade floors: For slab-on-grade floors, the thermal resistance of the insulation around the perimeter of the floor shall not be less than the value given in Table No. 502.2.1. In climates below 6,000 annual Fahrenheit heating degree days (HDD), the insulation shall extend downward from the top of the slab for a minimum distance of 24 inches or downward to the bottom of the slab and then horizontally beneath the slab for a minimum total distance of 24 inches and shall be an approved type. In climates equal to or greater than 6,000 annual Fahrenheit heating degree days (HDD), the insulation shall extend downward from the top of the slab for a minimum of 48 inches or downward to the bottom of the slab and then horizontally for a minimum total distance of 48 inches.~~

~~502.2.1.5 Crawl space walls: The exterior walls of crawl spaces below uninsulated floors shall have a thermal transmittance value not exceeding the value given in Table No. 502.2.1. Where the inside ground surface is less than 12 inches below the outside finish ground level, crawl space wall insulation shall extend vertically and horizontally a minimum total distance of 24 inches linearly from the outside finish ground level.~~

~~Where crawl spaces below uninsulated floors are ventilated to the outside, the vent area shall be provided at a radio of one square foot per 1,500 square feet of crawl space floor area, and the ground surface (floor) within the crawl space shall be covered with a material having a perm rating of one or less.~~

~~502.2.1.6 Basement walls: The exterior walls of basements below uninsulated floors shall have a transmittance value not exceeding the value given in Table No. 502.2.1 to a depth of 10 feet below the outside finish ground level, or the level of the basement floor, whichever is less.~~

(Table No. 502.2.1 is deleted.)

502.2.1 Target UA approach: The proposed UA as calculated using Equations 2 and 3 shall not exceed the Target UA as calculated using Equation 1. For the purpose of determining equivalent thermal performance, the glazing area for the target UA shall be calculated using figures in Table No. 5-1, and all the glazing shall be located in the wall area. The opaque door area shall be the same in the target UA and the proposed UA.

(Table No. 5-1 is entirely new and is not underlined.)

TABLE NO. 5-1 (Section 502.2.1)
TARGET COMPONENT REQUIREMENTS FOR ALL GROUP R OCCUPANCY

COMPONENT		TARGET REQUIREMENT	
Space Heating System		Electric resistance	Heat pump, natural gas, oil, steam and other
Glazing % Floor Area		15%	15%
Glazing U-Factor		U = 0.400	U = 0.650
Doors		U = 0.200 (R = 5)	U = 0.400 (R = 2.5)
Ceilings:			
Attic		U = 0.031 (R = 38)	U = 0.036 (R = 30)
Single Rafter/ Joist Vaulted		U = 0.034 (R = 30)	U = 0.034 (R = 30)
Walls		U = 0.058 (R = 19A)	U = 0.062 (R = 19)
Floors		U = 0.029 (R = 30)	U = 0.041 (R = 19)
Slab on Grade		F = 0.54	F = 0.54
Slab R-Value		(R = 10)	(R = 10)
Below Grade Interior			
Wall R-Value		(R = 19)	(R = 19)
2′ Depth:	Walls	U = 0.043	U = 0.043
	Slab	F = .69	F = .69
3.5′ Depth:	Walls	U = 0.041	U = 0.041
	Slab	F = 0.64	F = 0.64
7′ Depth:	Walls	U = 0.037	U = 0.037
	Slab	F = 0.57	F = 0.57
Below Grade Exterior			
Wall R-Value		(R = 10)	(R = 10)
2′ Depth:	Walls	U = 0.070	U = 0.070
	Slab	F = 0.60	F = 0.60
3.5′ Depth:	Walls	U = 0.064	U = 0.064
	Slab	F = 0.57	F = 0.57
7′ Depth:	Walls	U = 0.056	U = 0.056
	Slab	F = 0.42	F = 0.42

502.2.2 Prescriptive approach

The building envelope requirements may be met by installing one of the prescriptive packages in Table Nos. 6-1 to 6-6. Compliance with nominal R-Values shall be demonstrated for the thermal resistance of the added insulation in framing cavities and/or insulated sheathing only and shall not include the thermal

transmittance of other building materials or air films, but shall permit interruption by occasional framing members.

502.2.2.1 Roof/ceiling: Ceilings below vented attics and single-rafter, joist-vaulted ceilings shall be insulated to not less than the nominal R-value specified for ceilings in Table Nos. 6-1 to 6-6 as applicable.

502.2.2.2 Exterior walls both above and below grade: Above grade exterior walls shall be insulated to not less than the nominal R-value specified in Table Nos. 6-1 to 6-6 as applicable. The following walls should be considered to meet R-19 without additional documentation:

1. 2 x 6 framed and insulated with R-19 fiberglass batts.
2. 2 x 4 framed and insulated with R-13 fiberglass batts plus R-3.2 foam sheathing.
3. 2 x 4 framed and insulated with R-11 fiberglass batts plus R-5.0 foam sheathing.

502.2.2.3 Exterior walls (below grade): Below grade exterior walls surrounding conditioned space shall be insulated to not less than the nominal R-value specified for below grade walls in Table Nos. 6-1 to 6-6 as applicable.

502.2.2.4 Slab-on-grade floors: Slab-on-grade floors shall be insulated along their perimeter to not less than the nominal R-values specified for slab-on-grade floors in Table Nos. 6-1 to 6-6 as applicable. Slab insulation shall be installed in compliance with Section 502.1.4.8. See Section 502.1.4.9, for additional requirements for radiant slab heating.

502.2.2.5 Floors over unconditioned space: Floors over unconditioned spaces, such as vented crawl spaces, unconditioned basements, and parking garages shall be insulated to not less than the nominal R-value shown for floors over unconditioned spaces, in Table Nos. 6-1 to 6-6.

502.2.2.6 Exterior doors: For all doors which are less than 50% glazing, including fire doors, the opaque door area shall have a maximum area weighted average U-value not exceeding that shown in Table Nos. 6-1 to 6-6 and the glazing shall comply with Section 502.2.2.7. U-values for the opaque door area shall be determined in accordance with Section 502.1.5.1. For all doors which are 50% or more glazing, the entire door area shall comply with the glazing requirements in Section 502.2.2.7.

Exception: Doors whose area and U-value are included in the calculations for compliance with the requirements for glazing in Section 502.2.2.7 shall be exempt from the U-value requirements stated above.

502.2.2.7 Glazing

502.2.2.7.1 Glazing area: The total glazing area as defined in Chapter 2 shall not exceed the percentage of gross conditioned floor area specified in Table Nos. 6-1 to 6-6. This area shall also include any doors using the exception of Section 502.2.2.6.

502.2.2.7.2 Glazing U-values: The total glazing area as defined in Chapter 2 shall have an area weighted average U-value not to

exceed that specified in Table Nos. 6-1 to 6-6. U-values for glazing shall be determined in accordance with Section 502.1.5.1. These areas and U-values shall also include any doors using the exception of Section 502.2.2.6.

If the U-values for all glazing products are below the U-value specified, then no calculations are required. If compliance is to be achieved through an area weighted calculation, then the areas and U-values shall be included in the plans submitted with a building permit application.

Exception: Single glazing for ornamental, security, or architectural purposes shall have its area doubled and shall be included in the percentage of the total glazing area as allowed for in Table Nos. 6-1 to 6-6. The maximum area (before doubling) allowed for the total of all single glazing is 1% of the floor area.

(Table Nos. 6-1, 6-2, 6-5 and 6-6 are entirely new and are not underlined.)

TABLE NO. 6-1 (Section 502.2.2)
PRESCRIPTIVE REQUIREMENTS[1] FOR GROUP R OCCUPANCY
HEATING BY ELECTRIC RESISTANCE

OPTION	GLAZING % FLOOR AREA	GLAZING U-VALUE	DOORS U-VALUE	CEILING[2]	VAULTED CEILING[3]	WALL ABOVE GRADE	WALL-int[4] BELOW GRADE	WALL-ext[4] BELOW GRADE	FLOOR[5]	SLAB[6] ON GRADE
I.	10%	0.46	0.40	R-38	R-30	R-21	R-21	R-10	R-30	R-10
II.	12%	0.43	0.20	R-38	R-30	R-19	R-19	R-10	R-30	R-10
III.	12%	0.40	0.40	R-38	R-30	R-21	R-21	R-10	R-30	R-10
IV.*	**15%**	**0.40**	**0.20**	**R-38**	**R-30**	**R-19**	**R-19**	**R-10**	**R-30**	**R-10**
V.	18%	0.39	0.20	R-38	R-30	R-21	R-21	R-10	R-30	R-10
VI.	21%	0.36	0.20	R-38	R-30	R-21	R-21	R-10	R-30	R-10
VII.	25%	0.32[7]	0.20	R-38	R-30	R-19+ R-5[8]	R-21	R-10	R-30	R-10
VIII.	30%	0.29[7]	0.20	R-38	R-30	R-19+ R-5[8]	R-21	R-10	R-30	R-10

* Reference Case (highlighted in boldface)

[1] Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 19%, it shall comply with all of the requirements of the 21% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above, may calculate compliance by Chapter 4 or Section 502.2.1 of this code.

[2] Requirement applies to all ceilings except single rafter or joist vaulted ceilings. "Adv" denotes Advanced Framed Ceiling.

[3] Requirement applicable only to single rafter or joist vaulted ceilings.

[4] Below grade walls shall be insulated either on the exterior to a minimum level of R-10,or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 502.2.2.2.

[5] Floors over crawl spaces or exposed to ambient air conditions.

[6] Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 502.2.2.4.

[7] These options shall be applicable to buildings less than three stories: 0.35 maximum for glazing areas of 25% or less; 0.32 maximum for glazing areas of 30% or less.

[8] This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.

TABLE NO. 6-2 (Section 502.2.2)
PRESCRIPTIVE REQUIREMENTS[1] FOR GROUP R OCCUPANCY
HEATING BY OTHER FUELS

OPTION	HVAC[9] EQUIP. EFFIC.	GLAZING % FLOOR AREA	GLAZING U-VALUE	DOORS U-VALUE	CEILING[2]	VAULTED CEILING[3]	WALL ABOVE GRADE	WALL-int[4] BELOW GRADE	FLOOR[5]	SLAB[6] ON GRADE
I.	Med.	10%	0.70	0.40	R-30	R-30	R-15	R-15	R-19	R-10
II.	Med.	12%	0.65	0.40	R-30	R-30	R-15	R-15	R-19	R-10
III.	High	21%	0.75	0.40	R-30	R-30	R-19	R-19	R-19	R-10
IV.*	**Med.**	**21%**	**0.65**	**0.40**	**R-30**	**R-30**	**R-19**	**R-19**	**R-19**	**R-10**
V.	Low	21%	0.60	0.40	R-30	R-30	R-19	R-19	R-19	R-10
VI.	Med.	25%	0.45[7]	0.40	R-38	R-30	R-19	R-19	R-25	R-10
VII.	Med.	30%	0.40[7]	0.40	R-38	R-30	R-19	R-19	R-25	R-10

* Reference Case (highlighted in boldface)

[1] Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 19%, it shall comply with all of the requirements of the 21% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above, may calculate compliance by Chapter 4 or Section 502.2.1 of this code.

[2] Requirement applies to all ceilings except single rafter or joist vaulted ceilings. `Adv´ denotes Advanced Framed Ceiling.

[3] Requirement applicable only to single rafter or joist vaulted ceilings.

[4] Below grade walls shall be insulated either on the exterior to a minimum level of R-10,or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 502.2.2.2.

[5] Floors over crawl spaces or exposed to ambient air conditions.

[6] Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 502.2.2.4.

[7] These options shall be applicable to buildings less than three stories: 0.50 for glazing areas of 25% or less; 0.45 for glazing areas of 30% or less.

[8] This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.

[9] Minimum HVAC Equipment efficiency requirement. `Low´denotes an AFUE of 0.74 and an HSPF of 6.35. `Med.´denotes an AFUE of 0.78 and an HSPF of 6.8. `High´denotes an AFUE of 0.88 and an HSPF of 7.4.

(Table Nos. 6-3 and 6-4 are reserved for numbering consistency.)

TABLE NO. 6-5 (Section 502.2.2)
LOG HOMES PRESCRIPTIVE REQUIREMENTS[1]
HEATING BY ELECTRIC RESISTANCE

OPTION	AVERAGE[2] LOG THICKNESS	GLAZING % FLOOR AREA	GLAZING U-VALUE	DOORS U-VALUE	CEILING[3]	VAULTED[4] CEILING	FLOOR[5]	SLAB[6] ON GRADE
I.[7]	5.5"	15%	0.31	0.14	R-60 Adv	R-38	R-38	R-10
II.[7]	7.5"	15%	0.40	0.20	R-60 Adv	R-38	R-30	R-10
III.*	**9.6"**	**15%**	**0.40**	**0.20**	**R-38**	**R-30**	**R-30**	**R-10**

* Reference Case (highlighted in boldface)

[1] For Group R Occupancy use Table No. 6-5 for only the portion of floor area using log/solid timber walls. Use Table Nos. 6-1 to 6-2 for all other portions of the floor area. Minimum requirements are for each option listed. Interpolations between options is not permitted. Proposed designs which cannot meet the specific requirements of a listed option above, may calculate compliance by Chapter 4 or Section 502.2.1 of this code.

[2] Required minimum average log thickness.

[3] 'Adv' denotes Advanced Framing. Requirement applies to all ceilings except single rafter joist vaulted ceiling.

[4] Requirement applicable only to single rafter joist vaulted ceilings.

[5] Floors over crawl spaces or exposed to ambient air conditions.

[6] Required slab perimeter insulation shall be water-resistant material, manufactured for its intended use, and installed according to manufacturer's specifications.

[7] These options shall be applicable to buildings less than three stories.

TABLE NO. 6-6 (Section 502.2.2)
LOG HOMES PRESCRIPTIVE REQUIREMENTS[1]
HEATING BY OTHER FUELS

OPTION	AVERAGE[2] LOG THICKNESS	GLAZING % FLOOR AREA	GLAZING U-VALUE	DOORS U-VALUE	CEILING[3]	VAULTED[4] CEILING	FLOOR[5]	SLAB[6] ON GRADE
I.[7]	3.5"	21%	0.40	0.39	R-49 Adv	R-38	R-30	R-10
II.	4.4"	21%	0.40	0.40	R-38	R-30	R-19	R-10
III.	5.2"	21%	0.50	0.40	R-38	R-30	R-19	R-10
IV.	6.5"	21%	0.60	0.40	R-38	R-30	R-19	R-10
V.	7.0"	21%	0.60	0.40	R-38	R-30	R-19	R-10
VI.*	**8.2"**	**21%**	**0.65**	**0.40**	**R-38**	**R-30**	**R-19**	**R-10**

* Reference Case (highlighted in boldface)

[1] For Group R Occupancy use Table No. 6-6 for only the portion of floor area using log/solid timber walls. Use Table Nos. 6-1 to 6-2 for all other portions of the floor area. Minimum requirements are for each option listed. Interpolations between options is not permitted. Proposed designs which cannot meet the specific requirements of a listed option above, may calculate compliance by Chapters 4 or Section 502.2.1 of this code.

[2] Required minimum average log thickness.

[3] 'Adv' denotes Advanced Framing. Requirement applies to all ceilings except single rafter joist vaulted ceiling.

[4] Requirement applicable only to single rafter joist vaulted ceilings.

[5] Floors over crawl spaces or exposed to ambient air conditions.

[6] Required slab perimeter insulation shall be water-resistant material, manufactured for its intended use, and installed according to manufacturer's specifications.

[7] These options shall be applicable to buildings less than three stories.

502.3 Criteria for all Other than Group R Occupancy ((~~buildings~~)): Compliance with the building envelope requirements of this code shall be demonstrated by using the Target UA Approach in Section 502.3.1 based on the values in Table No. 5-2 or, for the gross exterior wall area, based on the ENVSTD diskette version 2.1 or 2.2 of ASHRAE/IES Standard 90.1; or by using the Prescriptive Approach in Section 502.3.2. These requirements apply to all heated and/or cooled spaces, including semi-heated spaces as defined in Section 201. Semi-heated spaces need only comply with the requirements of Footnote 8, Table No. 5-2. Unless otherwise approved by the Building Official, all spaces shall be assumed to be at least semi-heated.

Exception: Skylights for which daylight credit is taken may be excluded from the requirements and calculations of the roof assembly (U_{rc}) if all of the following conditions are met:

(a) The opaque roof thermal transmittance value U_{rc} does not exceed the value in Table No. 5-2.

(b) Skylit areas, including framing, as a percentage of the roof area do not exceed the values specified below where Visible Light Transmittance (VLT) is the transmittance of a particular glazing material over the visible portion of the solar spectrum. (Skylight areas shall be interpolated only between visible light transmittance values of 0.75 and 0.50.)

- Skylights over areas with a total lighting wattage of less than 2.0 watts per square foot: (1) 4% where VLT is 0.75 maximum and (2) 6% where VLT is 0.50 maximum.

- Skylights over areas with a total lighting wattage of 2.0 watts per square foot and greater: (1) 8% where VLT is 0.75 maximum and (2) 12% where VLT is 0.50 maximum.

(c) All electric lighting fixtures within daylighted areas under skylights are controlled by automatic daylighting controls. Daylight areas under skylights shall be defined as the daylight area beneath each skylight whose dimension in each direction (centered on the skylight) is equal to the skylight dimension in that direction plus the dimension of the floor to ceiling height.

(d) The overall thermal transmittance U_o value of the skylight assembly including framing is equal to or less than 0.70 Btu/h·ft^2·°F.

(e) Skylit curbs have thermal transmittance U values less than or equal to 0.21 Btu/h·ft^2·°F.

(f) The infiltration coefficient of the skylights is less than or equal to 0.05 cfm/ft^2.

((~~502.3.1 Heating criteria~~

~~502.3.1.1 Walls: A building other than a Group R building regulated by Section 502.2 that is heated shall have a combined thermal transmittance value (U_o) of the gross area of exterior walls not exceeding the values given in Table No. 502.3.1. Equation 1 shall be used to determine acceptable combinations to meet this requirement.~~

~~502.3.1.2 Roof/ceiling: A building that is heated and/or mechanically cooled shall have a combined thermal transmittance value (U_o) for the gross area of the roof assembly not exceeding the value given in Table No. 502.3.1. Equation 2 shall be used to determine acceptable combinations to meet this requirement.~~

~~502.3.1.3 Floors over unheated spaces: For floors of heated spaces over unheated spaces, the U_o value shall not exceed the value given in Table No. 502.3.1 For floors over outdoor air, i.e., overhangs, U_o values for heating shall meet the same requirements as shown for roofs in Table No. 502.3.1.~~

~~502.3.1.4 Slab-on-grade floors: For slab-on-grade floors, the thermal resistance of the insulation around the perimeter of the floor shall be not less than the value given in Table No. 502.3.1. In climates below 6,000 annual Fahrenheit heating degree days (HDD), the insulation shall extend downward from the top of the slab for a minimum distance of 24 inches or downward to the bottom of the slab and then horizontally beneath the slab for a minimum total distance of 24 inches and shall be of an approved type. In climates equal to or greater then 6,000 annual Fahrenheit heating degree days (HDD), the insulation shall extend downward from the top of the slab for a minimum of 48 inches or downward to the bottom of the slab and then horizontally for a minimum total distance of 48 inches.~~

~~502.3.1.5 Crawl space walls: The exterior walls of crawl spaces below uninsulated floors shall have a thermal transmittance value not exceeding the value given in Table No. 502.3.1. Where the inside ground surface is less than 12 inches below the outside finish ground level, crawl space wall insulation shall extend vertically and horizontally a minimum total distance of 24 inches linearly from the outside finish ground level.~~

~~Where crawl spaces below uninsulated floors are ventilated to the outside, the vent area shall be provided at a ratio of one square foot per 1,500 square feet of crawl space floor area, and the ground surface (floor) within the crawl space shall be covered with a material having a perm rating of one or less.~~

~~502.3.1.6 Basement walls: The exterior walls of the basements below uninsulated floors shall have a thermal transmittance value not exceeding the value given in Table No. 502.3.1 to a depth of 10 feet below the outside finish ground level or to the level of the basement floor, whichever is less.~~))

502.3.1 Target UA approach: The proposed UA as calculated using Equations 2 and 5 shall not exceed the Target UA as calculated using Equation 4. For the purpose of determining equivalent thermal performance, the glazing area, U-value and shading coefficient package for the Target UA shall be for a glazing area which is greater than the proposed design. The shading coefficient for the proposed design shall not exceed the Target shading coefficient. For the Target UA, all glazing shall be located in the wall area. U-value calculations shall be performed in accordance with the requirements of Section 502.1.

As an alternate for the gross exterior wall area (including window, door and opaque wall assemblies), compliance may also be demonstrated using the ENVSTD diskette version 2.1 or 2.2 of ASHRAE/IES Standard 90.1 using the requirements for calculations in Section 502.1. When using this approach for spaces which are both heated and cooled, compliance is only required with the

total criteria, not the individual criteria for heating or for cooling. It is acceptable to use this method to make tradeoffs between heating and cooling criteria in the gross exterior wall area without performing the annual energy analysis in Chapter 4. It is also possible to take credit for shading due to window setback.

Exception: Glazing which complies with all the requirements for Section 502.3.2(e) exception 1 or 2 shall also be exempted from the area and U-value calculations of this section.

502.3.2 Prescriptive approach: The envelope design of the building being evaluated is in compliance with the prescriptive criteria of Section 502.3.2 provided that all of the following are met:

(a) The proposed design meets the basic requirements of Sections 502.1 and 502.4. The calculation procedures of Section 502.1 shall be used to demonstrate compliance with the basic requirements.

(b) All roofs, walls above and below grade, floors over unconditioned spaces and slab on grade floors shall have insulation with a nominal R-value no less than that specified in the prescriptive approach of Table No. 5-2. Slab-on-grade floor insulation shall be installed per Section 502.1.4.5. For heated slabs, an R of 2 shall be added to the thermal resistance requirement.

(c) All glazing and doors shall have an area-weighted U-value not to exceed that specified in Table No. 5-2 for the appropriate glazing area and shading coefficient.

(d) All glazing shall have an area-weighted shading coefficient not to exceed that specified in Table No. 5-2 for the appropriate glazing area and U-value.

(e) The percentage of total fenestration, including non-exempt skylights, relative to the gross exterior wall area is less than or equal to the appropriate value from Table No. 5-2 for the glazing U-value and shading coefficient selected.

Exceptions: Provided that the glazing is double-glazing with a minimum 1/2 inch airspace:

1. To make streets an enjoyable and pleasant place to be and to provide visual interest, the maximum allowable total glazing area may be increased to 75 percent for that portion of the gross area of the exterior wall of a street level story both which does not exceed 20 feet in height and which is within ten feet of a street property line.

2. For the applicable portion of the building envelope, the maximum allowable total glazing area may be increased to 15 percent above a minimum glazing percentage which is required by the Seattle Downtown Land Use Code or the Neighborhood Commercial Areas Land Use Code or is a requirement for a downtown public benefit feature which has been approved by the building official. The maximum allowable total glazing area so defined shall not exceed 75 percent.

Vertical glazing only is exempt from the maximum shading coefficient requirements. When these allowances are utilized, separate calculations shall be performed for these sections of the building envelope and these values shall not be averaged with any others for compliance purposes.

((~~502.3.2 Cooling criteria~~

~~502.3.2.1 Walls: A building that is mechanically cooled shall have an overall thermal transfer value, $OTTV_W$, for the gross area of exterior walls above grade, not exceeding the values given in Table No. 502.3.1. Equation 3 shall be used to determine acceptable combinations to meet these requirements.~~

~~502.3.2.2 Roof/ceiling: A building that is mechanically cooled shall have a combined thermal transmittance value (U_O) for the roof/ceiling not exceeding that specified in Table No. 502.3.1. A building that is mechanically cooled shall have an overall thermal transfer value, ($OTTV_R$), for the gross area of a roof assembly not exceeding the value given in Table No. 502.3.1. Equation 4 shall be used to determine acceptable combinations to meet these requirements.~~

~~502.3.2.3 Exposed floors: A building that is mechanically cooled shall have a combined thermal transmittance value (U_O) for floors exposed to outdoor air not to exceed that determined by Section 502.3.1.3.~~))

(Table No. 5-2 is entirely new and is not underlined.)

TABLE NO. 5-2 (Section 502.3)
COMPONENT REQUIREMENTS FOR OTHER THAN GROUP R OCCUPANCY

COMPONENT	REQUIREMENT
BUILDING ENVELOPE - PRESCRIPTIVE APPROACH[1,8]	
Roof/ceiling insulation	
three conditioned stories or less	R-30 min.
more than three conditioned stories	R-19 min.
Exterior wall insulation	R-11[2,5,7] min.
Floor insulation	R-19 min.
Slab-on-grade insulation	R-14[9] min.
Door U-value	0.47[3] max.

Glazing area (max. % of wall)	0-20%	0-30%	0-40%	0-50%	0-70%
Glazing U-value max.[4,5,6]	.72	.60	.49	.39	.30
Glazing shading coefficient max.[5,6]	1.00	.60	.45	.40	.30

BUILDING ENVELOPE - TARGET UA APPROACH[1,8,10]	
Roof/ceiling U_o-value	
three conditioned stories or less	U-.036 max.
more than three conditioned stories	U-.064 max.
Opaque exterior wall U_o value	U-.14[2,5,7] max.
Floor U_o-value	U-.056 max.
Slab on grade F-value	F-.56 max.

Glazing area (max. % of wall)	0-20%	0-30%	0-40%	0-50%	0-70%
Glazing U-value max.[4,5,6]	.72	.60	.49	.39	.30
Glazing shading coefficient max.[5,6]	1.00	.60	.45	.40	.30

1 R values are for installed insulation material only, U_o values include the entire heat flow path from inside to outside, including attics and crawlspaces.

2 R-9 minimum for below grade walls. No insulation is required for those portions of below grade walls more than ten feet below grade. Below grade walls, however, shall not be included in the gross exterior wall area unless insulated to R-9 minimum.

3 See Section 201 for glazing and door definitions and Chapter 10 for examples.

4 The following glazing products are deemed to comply with the U-value specified provided that all airspaces are each at least 1/2 inch wide and all low-emissivity coatings have a maximum emissivity of 0.15 (the U-values for glazing products with airspaces less than 1/2 inch and low-E coatings with emissivities higher than 0.15 shall be determined in accordance with Section 502.1.5):

.72 - double glazing in any frame type.
.60 - double glazing in a frame having a thermal break or double w/low-E in any type of frame.
.49 - double glazing in a wood or vinyl frame or double w/low-E in a metal frame having a thermal break.
.39 - double w/low-E in a wood or vinyl frame or triple w/low-E in a metal frame having a thermal break.
.30 - triple w/low-E in a wood or vinyl frame.

5 For glazing areas of 40% or less only, if the wall insulation is R-19 minimum or U_o - .11 maximum then either the maximum glazing U-value or shading coefficient allowed may be increased by .05.

6 Where the glazing area does not exceed 30%, the glazing U-value may be increased to 0.72 if the shading coefficient does not exceed 0.45.
Where the glazing area does not exceed 40%, the glazing U-value may be increased to 0.60, if the shading coefficient does not exceed 0.30.
Where the glazing area does not exceed 50%, the glazing U-value may be increased to 0.49, if the shading coefficient does not exceed 0.25.
Where the glazing area does not exceed 70%, the glazing U-value may be increased to 0.39, if the shading coefficient does not exceed 0.20.

7 For thermal mass walls which have a heat capacity of 9.6 Btu/ft^2·°F minimum and where either:
a. the glazing area does not exceed 15%, the glazing U-value does not exceed 0.75 and the shading coefficient does not exceed 1.00; or
b. the glazing area does not exceed 25%, the glazing U-value does not exceed 0.60 and the shading coefficient does not exceed 0.60;
Then the minimum interior insulation may be reduced to R-5 and the U-value increased to 0.19; or the minimum exterior insulation may be reduced to R-3 and the U-value increased to 0.25; or for integral insulation concrete blocks shall have a minimum thickness of eight inches, a maximum density of 110 pounds per cubic foot and all cores shall be filled with vermiculite insulation having an R-value of 2.2 per inch. See Section 201 for definition of thermal mass wall insulation position.

8 For semi-heated spaces as defined in Section 201, the only building envelope requirement is that the roof/ceiling have a U-0.10 maximum. Prescriptively, this can be achieved by:
a. for all buildings, R-9 minimum insulation where the insulation is entirely outside of the roof structure and installed in a continuous manner; or
b. for wood-frame roofs, R-11 minimum insulation where the insulation is installed inside or within the roof structure and the framing material is wood; or
c. for metal-frame roofs, R-19 minimum insulation where the insulation is installed inside or within the roof structure.

9 If the slab insulation extends downward from the top of the slab vertically for 24 inches, then the minimum insulation may be reduced to R-7.

10 As an alternate for the gross exterior wall area (including windows, doors and opaque wall assemblies), compliance may also be demonstrated using the ENVSTD diskette version 2.1 or 2.2 of ASHRAE/IES Standard 90.1.

502.4 Air leakage for all buildings

502.4.1: The requirements of this section shall apply to all buildings and structures, or portions thereof, and apply to those

locations separating outdoor ambient conditions from interior spaces that are heated or mechanically cooled ((~~and are not applicable to the separa-tion of interior conditioned spaces from each other~~)).

502.4.2: Exterior doors and windows shall be designed to limit air leakage into or from the building envelope. ((~~Manufactured doors and windows shall have air infiltration rates not exceeding those shown in Table No. 502.4.2~~)) Site-constructed doors and windows shall be sealed in accordance with 502.4.3.

For Other than Group R Occupancy:

(a) Fenestration shall meet one of the following standards for air leakage:

1. ANSI/AAMA 101-1988 Aluminum Prime Windows.

2. ASTM D 4099-89, Poly (Vinyl Chloride) (PVC) Prime Windows.

3. ANSI/NWWDA I.S. 2-87 Wood Window Units (Improved Performance Rating Only).

(b) Sliding doors shall meet one of the following standards for air leakage:

1. ANSI/AAMA 101-1988 Aluminum Sliding Glass Doors.

2. ANSI/NWWDA I.S. 3-83 Wood Sliding Patio Doors.

(c) Commercial entrance swinging or revolving doors shall limit air leakage to a rate not to exceed 1.25 cfm/ft^2 of door area, when tested at standard test conditions in accordance with ASTM E283-84.

(Table No. 502.4.2 is deleted.)

502.4.3: Exterior joints ((~~in the building envelope that are sources of air leakage, such as~~)) around window and door frames; ((~~between wall cavities and window or door frames;~~)) openings between walls and foundations, between walls and roof/ceilings and ((~~between~~)) wall panels; openings at penetrations of utility services through walls, floors and roofs; and all other ((~~such~~)) openings in the building envelope for all occupancies and all other opening in between units in R-1 occupancy shall be sealed, caulked, gasketed, or weatherstripped ((~~or otherwise sealed in an approved manner~~)) to limit air leakage.

All exterior doors or doors serving as an access to an enclosed unheated area shall be weatherstripped to limit air leakage around their perimeter when in a closed position.

Site built windows are exempt from testing but shall be made tight fitting. Fixed lights shall have glass retained by stops with sealant or caulking all around. Operating sash shall have weatherstripping working against overlapping trim, and a closer/latch which will hold the sash closed. The window frame to framing crack shall be made tight with caulking, overlapping membrane, or other approved technique.

Openings required to be protected by fire-resistive assemblies are exempt from this section.

502.4.4 Recessed lighting fixtures: When installed in the building envelope, recessed lighting fixtures shall meet one of the following requirements:

1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.

2. Type IC or non-IC rated, installed inside a sealed box constructed from a minimum one half inch thick gypsum wall board or constructed from a preformed polymeric vapor barrier, or other air tight assembly manufactured for this purpose, while maintaining required clearances of not less than one half inch from combustible material and not less than three inches from insulation material.

3. Type IC rated, certified under ASTM E283 to have no more than 2.0 cfm air movement from the conditioned space to the ceiling cavity. The lighting fixture shall be tested at 75 Pascals or 1.57 lbs/ft^2 pressure difference and have a label attached, showing compliance.

(Equations 1-4 are deleted. New equations 1-5 have been added but are not underlined.)

EQUATION 1 GROUP R OCCUPANCY (Section 502.2.1)

Target UA

$$UA_t = U_wA_w + U_{bgw}A_{bgw} + U_gA_g + U_fA_f + U_{rc}A_{rc} + U_{cc}A_{cc} + U_dA_d + F_sP_s$$

Where:

UA_t = the target combined thermal transmittance of the gross exterior wall, floor and roof/ceiling assembly area.
U_w = the thermal transmittance value of the opaque above grade wall area found in Table No. 5-1.
A_w = opaque above grade wall area.
U_{bgw} = the thermal transmittance value of the below grade opaque wall area found in Table No. 5-1.
A_{bgw} = opaque below grade wall area.
U_g = the thermal transmittance value of the glazing area found in Table No. 5-1.
A_g = .15 (total floor area of the conditioned space).
U_f = the thermal transmittance value of the floor area found in Table No. 5-1.
A_f = floor area over unconditioned space.
U_{rc} = the thermal transmittance value of the roof/ceiling area found in Table No. 5-1.
A_{rc} = roof/ceiling area.
U_{cc} = the thermal transmittance value of the cathedral ceiling area found in Table No. 5-1.
A_{cc} = cathedral ceiling area.
U_d = the thermal transmittance value of the opaque door area found in Table No. 5-1.
A_d = opaque door area.
F_s = concrete slab component F-value found in Table No. 5-1.
P_s = lineal ft. of concrete slab perimeter.

EQUATION 2 ALL OCCUPANCIES (Section 502.2.1 and 502.3.1)

$$U = \frac{1}{r_o + R_1 + R_2 \ldots r_i}$$

Where:

U = the thermal transmittance of the assembly.
r_o = outside air film resistance;
r_o = 0.17 for all exterior surfaces.
r_i = inside air film resistance;
r_i = 0.61 for interior horizontal surfaces, heat flow up,
r_i = 0.92 for interior horizontal surfaces, heat flow down,
r_i = 0.68 for interior vertical surfaces.
R = $\frac{1}{C} = \frac{X}{K}$ = measure of the resistance to the passage of heat for each element.
C = conductance, the heat flow through a specific material of specific thickness.
K = insulation value of a material per inch.
X = the thickness of the material in inches.

EQUATION 3 GROUP R OCCUPANCY (Section 502.2.1)

Proposed UA

$$UA_p = U_wA_w + U_{bgw}A_{bgw} + U_gA_g + U_fA_f + U_{rc}A_{rc} + U_{cc}A_{cc} + U_dA_d + F_sP_s$$

Where:

UA_p = the proposed combined thermal transmittance of the gross exterior wall, floor and roof/ceiling assembly area.
U_w = the thermal transmittance of the opaque above grade wall area.
A_w = opaque above grade wall area.
U_{bgw} = the thermal transmittance value of the below grade opaque wall area.
A_{bgw} = opaque below grade wall area.
U_g = the thermal transmittance of the glazing (window or skylight) area.
A_g = glazing area, including windows in exterior doors.
U_f = the thermal transmittance of the floor area.
A_f = floor area over unconditioned space.
U_{rc} = the thermal transmittance of the roof/ceiling area.
A_{rc} = roof/ceiling area.
U_{cc} = the thermal transmittance of the cathedral ceiling area.
A_{cc} = cathedral ceiling area.
U_d = the thermal transmittance value of the opaque door area.
A_d = opaque door area.
F_s = concrete slab component F-factor.
P_s = lineal ft. of concrete slab perimeter.

NOTE: Where more than one type of wall, window, roof/ceiling, door, and skylight is used, the U and A terms for those items shall be expanded into sub-elements as:

$$U_{w1}A_{w1} + U_{w2}A_{w2} + U_{w3}A_{w3} + \ldots\text{etc.}$$

EQUATION 4 OTHER THAN GROUP R OCCUPANCY (Section 502.3.1)

Target UA

$$UA_t = U_wA_w + U_{bgw}A_{bgw} + U_gA_g + U_fA_f + U_{rc}A_{rc} + F_sP_s$$

Where:

UA_t = the target combined thermal transmittance of the gross exterior wall, floor and roof/ceiling assembly area.
U_w = the thermal transmittance of the opaque wall area from Table No. 5-2.
A_w = opaque wall area (gross exterior wall including doors minus glazing area)
U_{bgw}= the thermal transmittance value of the below grade opaque wall area.
A_{bgw}= opaque below grade wall area.
U_g = the thermal transmittance of the glazing from Table No. 5-2 for a glazing area larger than that in proposed design.
A_g = glazing area from Table No. 5-2 (shall be larger than that in proposed design).
U_f = the thermal transmittance of the floor area over unconditioned space from Table No. 5-2.
A_f = floor area over unconditioned space.
U_{rc} = the thermal transmittance of the roof/ceiling area from Table No. 5-2.
A_{rc} = roof/ceiling area.
F_s = concrete slab component F-factor from Table No. 5-2.
P_s = lineal ft. of concrete slab perimeter, same as proposed design.

EQUATION 5 OTHER THAN GROUP R OCCUPANCY (Section 502.3.1)

Proposed UA

$$UA_p = U_wA_w + U_{bgw}A_{bgw} + U_gA_g + U_fA_f + U_{rc}A_{rc} + U_{cc}A_{cc} + U_dA_d + F_sP_s$$

Where:

UA_p = the proposed combined thermal transmittance of the gross exterior wall, floor and roof/ceiling assembly area.
U_w = the thermal transmittance of the opaque wall area.
A_w = opaque wall area (not including doors).
U_{bgw}= the thermal transmittance value of the below grade opaque wall area.
A_{bgw}= opaque below grade wall area.
U_g = the thermal transmittance of the glazing (window or skylight) area.
A_g = glazing area, including skylights and windows in exterior doors.
U_f = the thermal transmittance of the floor area over unconditioned space.
A_f = floor area over unconditioned space.
U_{rc} = the thermal transmittance of the roof/ceiling area.
A_{rc} = roof/ceiling area.
U_{cc} = the thermal transmittance of the cathedral ceiling area.
A_{cc} = cathedral ceiling area.
U_d = thermal transmittance value of opaque door area.
A_d = opaque door area.
F_s = concrete slab component F-factor.
P_s = lineal ft. of concrete slab perimeter.

Note: Where more than one type of wall, window, roof/ceiling, door, and skylight is used, the U and A terms for those items shall be expanded into sub-elements as:

$$U_{w1}A_{w1} + U_{w2}A_{w2} + U_{w3}A_{w3} + \ldots\text{etc.}$$

Section 20: As of July 1, 1991, Section 503 of the 1989 Model Energy Code is amended, Table Nos. 503.4.2, 503.4.2a, 503.4.3, 503.4.5, 503.4.5a, 503.4.6, 503.4.6a, 503.4.7, 503.9.1 and 503.11 are deleted, and Table Nos. 5-6, 5-7, 5-8, 5-9, 5-11 and 5-12 and Equation 6 are added as follows:

SECTION 503 - BUILDING MECHANICAL SYSTEMS

503.1 General: This section covers the determination of heating and cooling loads, design requirements, system and component performance, control requirements, insulating systems and duct construction.

Exception: Special applications, including, but not limited to, hospitals, laboratories, thermally sensitive equipment rooms, computer rooms where a minimum of 90 percent of the total cooling load is due to computer equipment, and facilities with open refrigerated display cases may be exempted from the requirements of Section 503 when approved by the building official. Exemptions shall be specific on a case-by-case basis and allowed only to the extent necessary to accommodate the special applications.

503.2 Calculations of heating and cooling loads and system sizing limits: The design parameters specified in Chapter 3 shall apply for all computations.

503.2.1 Calculation procedures: Heating and cooling design loads for the purpose of sizing systems shall be determined in accordance with one of the procedures described in Chapters 25 and 26 of Standard RS-1 listed in Chapter 7 or an equivalent computation procedure.

503.2.2 Infiltration: Infiltration for heating and cooling design loads shall be calculated for all buildings except one- and two-family dwellings by the procedures in Chapter 22 of Standard RS-1 listed in Chapter 7. Calculations for one- and two-family dwellings may use the methods identified above or other accepted engineering practice.

503.2.3 Space heating and space cooling system sizing limits: Building mechanical systems for all buildings which provide space heating and/or space cooling shall be sized no greater than 150 percent of the design load as calculated above. No additional safety factor is allowed.

Exceptions: The following limited exemptions from the sizing limit shall be allowed, however, in all cases heating and/or cooling design load calculations shall be submitted.

1. For a single piece of equipment which has both heating and cooling capability, only one function, either the heating or the cooling, need meet the requirements of this section. Capacity for the other function shall be, within available equipment options, the smallest size necessary to meet the load.

2. Natural gas- or oil-fired space heating equipment whose total rated space heating output in any one dwelling unit is 56,000 Btu/h or less may exceed the 150 percent sizing limit provided that the installed equipment has an annual fuel utilization efficiency (AFUE) of not less than the sum of 78 percent plus 1 percent for every 5,000 Btu/h that the space heating equipment output exceeds the design heating load of the dwelling unit.

3. Stand-by equipment may be installed if controls and devices are provided which allow redundant equipment to operate automatically only when the primary equipment is not operating.

4. Multiple units of the same equipment type, such as multiple chillers and boilers, with combined capacities exceeding the design load may be specified to operate concurrently only if controls are provided that sequence or otherwise optimally control the operation of each unit based on load.

503.3 Separate air distribution systems, heat recovery systems and simultaneous heating and cooling: Use of a single air distribution system for multiple zones and of simultaneous heating and cooling by reheating or recooling supply air or by concurrent operation of independent heating and cooling systems serving a common zone shall be restricted as delineated below. Heat recovery systems shall be installed as indicated below.

503.3.1 Separate air distribution systems: Zones with special process temperature requirements, humidity requirements, or both, shall be served by air distribution systems separate from those serving zones requiring only comfort conditions; or shall include supplementary provisions so that the primary systems may be specifically controlled for comfort purposes only.

Exception: Zones requiring only comfort heating or comfort cooling that are served by a system primarily used for process temperature and humidity control need not be served by a separate system if the total supply air to these comfort zones is no more than 25% of the total system supply air or the total conditioned floor area of the zones is less than 1000 ft^2.

503.3.2 Simultaneous heating and cooling zone controls: Zone thermostatic and humidistatic controls shall be capable of operating in sequence the supply of heating and cooling energy to the zone. Such controls shall prevent:

- Reheating.
- Recooling.
- Mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by mechanical refrigeration or by economizer systems.
- Other simultaneous operation of heating and cooling systems to the same zone.

All systems which allow reheating are therefore prohibited, including, but not limited to, terminal reheat, dual duct and multizone systems, unless they comply with one or more of the following exceptions.

Exceptions: The following systems or zones are exempt from the requirements of Section 503.3.2, but shall comply with those in Section 503.3.3:

1. Variable air volume systems which have fan-powered terminal units on the perimeter zones controlled to utilize plenum heat prior to new energy being used for morning warm up; and which, during periods of occupancy, are capable of reducing the air supply to each zone to a minimum before reheating, recooling, or mixing takes place.

2. Zones where special pressurization relationships or cross-contamination requirements exist such as some areas of hospitals and laboratories, provided that the system complies with Section 503.3.4.

3. At least 75% of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered or site-solar energy source.

4. Zones where specified humidity levels are required to satisfy process needs, such as computer rooms and museums, provided that the system complies with Section 503.3.4.

5. Zones with a peak supply air quantity of 300 cfm or less.

503.3.3 System temperature reset controls

503.3.3.1 Air systems: Systems supplying heated or cooled air to multiple zones shall include controls which automatically reset supply air temperatures by representative building loads or by outside air temperature. Temperature shall be reset by at least 25% of the design supply-air-to-room-air temperature difference. Zones which are expected to experience relatively constant loads, such as interior zones, shall be designed for the fully reset supply temperature.

Exceptions

1. Systems which comply with 503.3.2 without using exceptions 1 or 2.

2. Where the supply air temperature reset increases overall building annual energy consumption.

503.3.3.2 Hydronic systems: Systems supplying heated and or chilled water to comfort conditioning systems shall include controls which automatically reset supply water temperatures by representative building loads (including return water temperature) or by outside air temperature. Temperature shall be reset by at least 25% of the design supply-to-return water temperature difference.

Exceptions

1. Where the supply temperature reset increases overall building annual energy consumption.

2. Systems for which supply temperature reset controls cannot be implemented without causing improper operation of heating, cooling, humidification, or dehumidification systems.

3. Systems with less than 600,000 Btu/hr design capacity.

503.3.4 Heat recovery system: A heat recovery system with a design recovery effectiveness of at least 50% shall be installed for all fan systems which have both a capacity of 5000 cfm (or greater) and a minimum outside air supply of 75% (or greater) of the total air circulated.

Exceptions

1. Laboratory systems equipped with both variable air volume supply and variable air volume exhaust fume hood controls.

2. Systems serving spaces heated to less than 60 degrees F.

3. Systems which can be shown to use as much energy with the addition of heat recovery equipment as without it.

4. Systems exhausting corrosive fumes making the installation of heat recovery equipment impractical.

5. Type I commercial kitchen hoods.

((~~503.3.1 Recovered energy: Recovered energy in excess of the new energy expended in the recovery process may be used for control of temperature and humidity.~~

~~503.3.2 New energy for humidity control: New energy may be used to prevent relative humidity from rising above 60 percent for comfort control or to prevent condensation on terminal units or outlets, or functioning special equipment.~~

~~503.3.3 New energy for temperature control: New energy may be used for temperature control if minimized in accordance with Sections 503.3.3.1 through 503.3.3.5.~~

~~503.3.3.1 Reheat systems: Systems employing reheat and serving multiple zones, other than those employing variable air volume for temperature control, shall be provided with control that will automatically reset the system cold-air supply to the highest temperature level that will satisfy the zone requiring the coolest air. Single-zone reheat systems shall be controlled to sequence reheat and cooling.~~

~~503.3.3.2 Dual duct and multizone systems: These systems, other than those employing variable air volume for temperature control, shall be provided with control that will automatically reset:~~

- ~~The cold-deck air supply to the highest temperature that will satisfy the zone requiring the coolest air; and,~~
- ~~The hot-deck air supply to the lowest temperature that will satisfy the zone requiring the warmest air.~~

~~503.3.3.3 Recooling systems: Systems in which heated air is recooled, directly or indirectly, to maintain space temperature shall be provided with control that will automatically reset the temperature to which the supply air is heated to the lowest level that will satisfy the zone requiring the warmest air.~~

~~503.3.3.4 Multiple zones: For systems with multiple zones, one or more zones may be chosen to represent a number of zones with similar heating/cooling characteristics. A multiple zone system~~

~~that employs reheating or recooling for control of not more than 5,000 cfm, or 20 percent of the total supply air of the system, whichever is less, shall be exempt from the supply-air-temperature reset requirement of Sections 503.3.3.1 through 503.3.3.3.~~

~~503.3.3.5 Concurrent operation: Concurrent operation of independent heating and cooling systems serving common spaces and requiring the use of new energy for heating or cooling shall be minimized by one or both of the following:~~

- ~~By providing sequential temperature control of both heating and cooling capacity in each zone.~~
- ~~By limiting the heat energy input through automatic reset control of the heating medium temperature (or energy input rate) to only that necessary to offset heat loss due to transmission and infiltration and, where applicable, to heat loss to transmission and infiltration and, where applicable, to heat the ventilation air supply to the space.~~))

503.4 HVAC equipment performance requirements

503.4.1 Minimum equipment efficiency: Equipment shall have a minimum efficiency, at the specified rating conditions, not less than the values shown in Table Nos. 5-6 through 5-9.

503.4.1.1: Equipment ratings certified under a nationally recognized certification program or rating procedure or data furnished by the equipment manufacturer shall be acceptable to satisfy these requirements.

503.4.1.2: Integrated part load value (IPLV) is the ARI descriptor for part-load efficiency for certain types of equipment. Compliance with minimum efficiency requirements specified for HVAC equipment shall include compliance with part-load requirements where indicated as well as standard or full-load requirements. The procedure for determining the IPLV is provided in the referenced ARI standards.

503.4.1.3: Space heating or cooling equipment used to provide additional functions (e.g. service water heating) as part of a combination (integrated) system shall comply with minimum performance requirements for the appropriate space heating or cooling equipment category.

503.4.1.4 Omissions: Omission of minimum performance requirements for certain classes of HVAC equipment does not preclude use of such equipment where appropriate.

503.4.2 Field assembled equipment and components

503.4.2.1: When components such as indoor or outdoor coils are used from more than one manufacturer as parts of air-conditioning or heating equipment, component efficiencies shall be specified based on data provided by the component manufacturers which shall provide components that are in compliance with the requirements of 503.4.1.

503.4.2.2: Total on-site energy input to the equipment shall be determined by combining the energy inputs to all components, elements, and accessories such as compressor(s), internal

circulating pump(s), condenser-air fan(s), evaporative-condenser cooling water pump(s), purge devices, viscosity control heaters, and controls.

503.4.2.3 Heat-operated water chilling packages: Double-effect, heat-operated water chilling packages shall be utilized in lieu of single-effect equipment, except where the energy input is from low temperature waste-heat or renewable energy sources.

((~~503.4.1 Equipment and components~~

~~503.4.1.1: The requirements of this section apply to equipment and mechanical component performance for heating, ventilating and airconditioning systems. Equipment efficiency levels are specified. Data furnished by the equipment supplier or certified under a nationally recognized certification program or rating procedure shall be used to satisfy these requirements. Equipment efficiencies shall be based on the standard rating conditions in Table Nos. 503.4.2a, 503.4.5a, or 503.4.6a as appropriate.~~

~~503.4.1.2: Where components from more than one manufacturer are assembled into systems regulated under this section, compliance shall be as specified in Sections 503.4.2 through 503.4.7.~~

~~503.4.2 HVAC system heating equipment heat pump-heating mode: Heat pumps whose energy input is entirely electric shall have a coefficient of performance (COP) heating, not less than the values in Table No. 503.4.2.~~

~~503.4.2.1: These requirements apply to, but not are limited to, unitary (central) heat pumps (air source and water source) in the heating mode, to water-source (hydronic) heat pumps as used in multiple-unit hydronic HVAC systems, and to heat pumps in the packaged terminal air-conditioner and room air-conditioner forms in the heating mode.~~

~~503.4.2.2 Coefficient of performance (COP) heating: The ratio of the rate of net heat output to the rate of total on-site energy input to the heat pump, expressed in consistent units and under designated rating conditions.~~

~~The rate of net heat output shall be defined as the change in the total heat content of the air entering and leaving the equipment (not including supplementary heat).~~

~~Total on-site energy input to the heat pump shall be determined by combining the energy inputs to all elements, except supplementary heaters, of the heat pump, including, but not limited to, compressor(s), compressor sump heater(s), pump(s), supply-air fan(s), return-air fan(s), outdoor-air fan(s), cooling-tower fan(s), and the HVAC system equipment control circuit.~~

~~503.4.2.3 Supplementary heater: The heat pump shall be installed with a control to prevent supplementary heater operation when the operating load can be met by the heat pump alone.~~

~~Supplementary heater operation is permitted during transient periods, such as start-ups, following room thermostat set-point advance and during defrost.~~

A two-stage thermostat, which controls the supplementary heat on its second stage, shall be accepted as meeting this requirement. The cut-on temperature for the compression heating shall be higher than the cut-on temperature for the supplementary heat, and the cut-off temperature for the compression heating shall be higher than the cutoff temperature for the supplementary heat. Supplementary heat may be derived from any source including, but not limited to, electric resistance, combustion heating or solar or stored-energy heating.

503.4.3 HVAC system combustion equipment: Gas- and oil-fired comfort heating equipment as listed below shall have a minimum combustion efficiency not less than the values in Table No. 503.4.3.

503.4.4 Mechanical ventilation: Each mechanical ventilation system (supply and/or exhaust) shall be equipped with a readily accessible switch or other means for shutoff or volume reduction and shutoff when ventilation is not required. Automatic or gravity dampers that close when the system is not operating shall be provided for outdoor air intakes and exhausts. There is no standard at this time for damper leakage. Automatic or manual dampers installed for the purpose of shutting off ventilation systems shall be designed with tight shutoff characteristics to minimize air leakage.

Exceptions

1. Manual dampers for outdoor air intakes may be used in the following cases:

   a. For single family and multifamily residential buildings.

   b. When the fan system capacity is less than 5,000 cfm.

2. Dampers are not required when ventilation airflow is less than 100 cfm.

503.4.5 HVAC system equipment, electrically operated, cooling mode: HVAC system equipment as listed below, whose energy input in the cooling mode is entirely electric, shall have an energy efficiency ratio (EER) or a coefficient of performance (COP) cooling not less than the values in Table No. 503.4.5.

503.4.5.1: These requirements apply to, but are not limited to, unitary (central) cooling equipment (air cooled, water cooled and evaporatively cooled); the cooling mode of unitary (central) and packaged terminal heat pumps (air source and water source); and packaged terminal air conditioners and room air conditioners.

Exception: These requirements do not apply to equipment used in areas such as supermarkets having open refrigerated food display cases or computers or other equipment contributing a large amount of heat to the area served.

503.4.5.2 Coefficient of performance (COP) cooling: The COP is the ratio of the rate of net heat removal to the rate of total on-site energy input to the air conditioner expressed in consistent units and under designated rating conditions.

The rate of net heat removal shall be defined as the change in the total heat content of the air entering and leaving the equipment (without reheat).

~~Total on-site energy input shall be determined by combining the energy inputs to all elements supplied with the package of the equipment including, but not limited to, compressor(s), compressor sump heater(s), pump(s), supply-air fan(s), return-air fan(s), condenser-air fan(s), cooling-tower fan(s) and pump(s) and the HVAC system equipment control circuit.~~

~~503.4.6 Applied HVAC system components, electrically operated, cooling mode: HVAC system components, as listed in Table No. 503.4.6, whose energy input is entirely electric, shall have an energy efficiency ratio (EER) or a coefficient of performance (COP) cooling not less than the values in Table No. 503.4.6.~~

~~503.4.6.1: Coefficient of performance (COP) cooling: The COP is the ratio of the rate of net heat removal to the rate of total on-site energy input, expressed in consistent units and under designated rating conditions.~~

~~The rate of net heat removal from the component is defined as the difference in total heat content of the water or refrigerant entering and leaving the component.~~

~~Total (on-site) energy input to the component shall be determined by the combining the energy inputs to all elements and accessories as included in the component, including, but not limited to, compressor(s), internal circulating pump(s), condenser-air fan(s), evaporative-condenser cooling water pump(s), purge devices, and the HVAC system component control circuit.~~

~~503.4.7 HVAC system equipment - heat opeated, cooling mode, efficiency limitation, equipment: Heat-operated cooling equipment shall have a COP cooling not less than the values in Table No. 503.4.7. These requirements apply to, but are not limited to, absorption equipment, engine-driven equipment and turbine-driven equipment. Table No. 503.4.7 defines the COP for HVAC system equipment in Footnote 2, which excludes electrical auxiliary inputs from the calculation of COP. However, the systems designer shall include electrical auxiliary inputs in calculating the total HVAC system COP.~~))

(Table Nos. 503.4.2., 503.4.2a, 503.4.3, 503.4.5, 503.4.5a, 503.4.6, 503.4.6a and 503.4.7 are deleted.)

(Table Nos. 5-6, 5-7, 5-8 and 5-9 are new and are not underlined.)

TABLE NO. 5-6 (Section 503.4)
HVAC SYSTEM HEATING EQUIPMENT-
GAS- AND OIL-FIRED
MINIMUM STEADY STATE COMBUSTION EFFICIENCY AND AFUE[6]

	FURNACES OF CAPACITY OF 225,000 BTU/H AND LESS, BOILERS OF CAPACITIES OF 300,000 BTU/H AND LESS [1,3]		ALL OTHER COMMERCIAL/ INDUSTRIAL FURNACES AND BOILERS[2]
TYPES OF EQUIPMENT	Comb. Eff.	AFUE	Comb. Eff. or AFUE
Forced-air furnaces			
gas-fired	80%[5]	78%	80%
oil-fired	80%[5]	78%	81%
Boilers			
gas-fired	-	80%[4]	80%
oil-fired	-	80%	83%
All other vented heating equipment	80%	-	80%

[1] When tested at the standard rating conditions in DOE Test Procedure 10 CFR, Part 30 for gas- and oil-fired units for furnaces less than 225,000 Btu/h and for boilers less than 300,000 Btu/h;

[2] Combustion efficiency of commercial/industrial furnaces and boilers is defined as 100 percent minus stack losses in percent of heat input at maximum rated capacity. Stack losses are:
Loss due to sensible heat in dry flue gas.
Loss due to incomplete combustion.
Loss due to sensible and latent heat in moisture formed by combustion of hydrogen in the fuel.
For detailed definition, see ANSI Z21.47-83 for gas-fired furnaces; U.L. Standard 727-86 for oil-fired furnaces; ANSI Z21.13-87 and Hydronics Institute Heating Boiler Standard 86 for gas-fired boilers; and U.L. Standard 726-75 and Hydronics Institute Heating Boiler Standard 86 for oil-fired (including residual) boilers.

[3] Group R Occupancy shall have a minimum AFUE of 78%. All other Group R Occupancy heating equipment fueled by gas, oil, or propane shall be equipped with an intermittent ignition device. HVAC Heating system efficiency trade-offs may be made using Chapter 4 or Table Nos. 6-2 or 6-6.

[4] Gas-fired steam boilers shall have a minimum AFUE of 75%.

[5] These requirements apply to combination units not covered by the National Appliance Energy Conservation Act (3 phase power or cooling capacity greater than 65,000 Btu/hr).

[6] For other than Group R Occupancy, prior to December 31, 1991, a minimum AFUE or combustion efficiency, as required, of 78% may be used for compliance.

TABLE NO. 5-7 (Section 503.4)
MINIMUM COP AND HSPF FOR HEAT PUMPS, HEATING MODE[1,2]

SOURCE AND TEMPERATURE (°F)	MINIMUM COP	MINIMUM HSPF
Air Source--47DB/43WB	3.0	-
Air Source--17DB/15WB	2.0	-
Air Source		
Split system	-	6.8
Single package system	-	6.6
Water Source--70 Entering	3.8	-
Ground Water Source--70 Entering	3.4	-
Ground Water Source--50 Entering	3.0	-

[1] When tested at the standard rating conditions in ARI Standard 210/240-89 for air-source heat pumps; ARI Standard 320-86 for water-source heat pumps; and ARI Standard 325-85 for ground-water-source heat pumps.

[2] For other than Group R Occupancy, prior to December 31, 1991, the following respective minimum values may be used for compliance: 2.8 COP, 1.9 COP and 6.4 HSPF for air-source heat pumps; 3.3 COP for water-source heat pumps; and 3.2 COP and 2.8 COP for groundwater-source heat pumps.

TABLE NO. 5-8 (Section 503.4)
MINIMUM EER AND COP FOR ELECTRICALLY DRIVEN HVAC-SYSTEM EQUIPMENT--COOLING[1,2]

STANDARD RATING CAPACITY	AIR-COOLED SEER	AIR-COOLED EER 95DB	AIR-COOLED IPLV 80DB	EVAP. OR WATER-COOLED EER 80DB/67WB	EVAP. OR WATER-COOLED IPLV
Under 65,000 Btu/hr					
Split system	10.0	9.5	8.5	9.3	8.5
Single package system	9.7	9.5	8.5	9.3	8.5
65,000 Btu/hr and over	-	8.9	8.3	10.5	9.7

[1] When tested at the standard rating conditions in ARI Standard 210/240-89 for air-cooled units; ARI Standard 210/240-89 for evaporatively-cooled units; and ARI Standards 210/240-89, 320-86 and 325-85 for water-cooled units. Temperatures are in degrees Fahrenheit. For evaporatively-cooled equipment, indoor temperatures are listed above, EER rating is at 95 DB/75 WB outdoor temperature and IPLV rating is at 80DB/67 WB outdoor temperature. For water-cooled equipment, EER rating is at 85 degree entering water temperature.

[2] Prior to December 31, 1991, the following respective minimum values may be used for compliance: 8.9 SEER, 8.6 SEER, - SEER, 8.4 EER, 8.4 EER, 8.3 EER, 7.4 IPLV, 7.4 IPLV and 7.3 IPLV for air-cooled units; 9.0 EER, 9.0 EER, 9.5 EER, 8.0 IPLV, 8.0 IPLV and 8.5 IPLV for evaporatively- and water-cooled units.

TABLE NO. 5-9 (Section 503.4)
MINIMUM COP AND IPLV FOR
WATER CHILLING PACKAGES - ELECTRICALLY OPERATED[1,2]

COMPONENT	MINIMUM COP	MINIMUM IPLV
Air-cooled		
with condenser	2.7	2.8
condenserless	3.1	3.2
Water-cooled		
300 tons and less	3.8	3.9
over 300 tons	5.2	5.3

[1] When tested at the standard rating conditions in ARI Standards 550-90 and 590-86.

[2] Prior to December 31, 1991, the following respective minimum values may be used for compliance: 2.6 COP, 3.0 COP, 2.6 IPLV and 3.0 IPLV for air-cooled units; and 3.7 COP, 4.6 COP, 3.8 IPLV and 4.7 IPLV for water-cooled units.

503.5 Transport energy

((~~503.5.1 All-air systems: The air transport factor for each all-air system shall be not less than 5.5. The factor shall be based on design system air flow for constant volume systems. The factor for variable air volume systems may be based on average conditions of operation. Energy for transfer of air through heat recovery devices shall not be included in determining the factor; however, such energy shall be included in the evaluation of the effectiveness of the heat recovery system.~~))

~~Air Transport Factor = Space Sensible Heat Removal* / Supply & Return Fan(s) Power Input*~~

~~*Expressed in Btu/h or watts~~

~~For purposes of these calculations, Space Sensible Heat Removal is equivalent to the maximum coincident design sensible cooling load of all spaces served for which the system provides cooling. Fan Power Input is the rate of energy delivered to the fan prime mover.~~

~~503.5.2 Other systems: Air and water, all-water and unitary systems employing chilled, hot, dual-temperature or condenser water-transport systems to space terminals shall not require greater transport energy (including central and terminal fan power and pump power) than an equivalent all-air system providing the same space sensible heat removal and having an air transport factor not less than 5.5.~~))

503.5.1 Fan system design criteria

503.5.1.1 General: The following design criteria apply to all HVAC fan systems used for any combination of comfort heating, ventilating, or air conditioning. For the purposes of this section, the energy demand of a fan system is the sum of the demand of all fans which are required to operate at design conditions to

supply air from the heating or cooling source to the conditioned space(s) and return it back to the source or exhaust it to the outdoors.

Exceptions

1. Systems with total fan system motor horsepower of 10 hp or less.

2. Unitary equipment for which the energy used by the fan is considered in the efficiency ratings of Section 503.4.

3. For the purposes of Section 503.5.1, total fan energy demand need not include the additional power required by air treatment or filtering systems with final pressure drops in excess of 0.6 in. W.C.

503.5.1.2 Constant volume fan systems: For fan systems which provide a constant air volume whenever the fans are operating, the power (brake horsepower divided by motor efficiency at design conditions) required by the motors for the combined fan system shall not exceed 0.80 W/cfm of supply air. For water-source heat pump systems, the power for system pumps shall be included in the calculations.

503.5.1.3 Variable air volume (VAV) fan systems: For fan systems which are able to vary system air volume automatically as a function of load, the power required by the motors for the combined fan system shall not exceed 1.25 W/cfm of supply air at design conditions.

503.5.1.4 Variable speed: For all motors which are 15 horsepower and larger, whenever variable output of a motor driven device is required, there shall be variable speed operation rather than the use of throttling, bypass, or similar devices.

Exception: Variable speed operation is not required for variable air volume fan systems which have inlet vane fans or equivalent wherever variable speed would have been required and for which the fan power does not exceed 0.90 W/cfm when calculated in accordance with Section 503.5.1.3.

503.6 Balancing: The HVAC system design shall provide means for balancing air and water systems. In doing so, the considerations shall include, but not be limited to, dampers, temperature and pressure test connections and balancing valves.

503.7 Cooling with outdoor air (economizer cycle)

((~~Each fan system shall be designed to use up to and including 100 percent of the fan system capacity for cooling with outdoor air automatically whenever its use will result in lower usage of new energy. Activation of economizer cycle shall be controlled by sensing outdoor air enthalpy or outdoor air dry-bulb temperature alone or alternate means approved by the building official.~~

~~Exceptions: Cooling with outdoor air is not required under any one or more of the following conditions:~~

~~1. The fan capacity is less than 5,000 cfm or total cooling capacity is less than 134,000 Btu/h.~~

~~2. The quality of the outdoor air is so poor as to require extensive treatment of the air and approval by the building official.~~

~~3. The need for humidification or dehumidification requires the use of more energy than is conserved by the outdoor air cooling on an annual basis.~~

~~4. The use of outdoor air cooling may affect the operation of other systems so as to increase the overall energy consumption of the building.~~

~~5. When energy recovered from an internal/external zone heat recovery system exceeds the energy conserved by outdoor air cooling on an annual basis.~~

~~6. Annual heating degree days are less than 1,200.~~

~~7. When all space cooling is accomplished by a circulating liquid which transfers space heating directly or indirectly to a heat rejection device such as a cooling tower without the use of a refrigeration system.~~

~~8. When outdoor wet-bulb design conditions exceed 72 degrees F. and annual Fahrenheit heating degree days are less than 2,000.~~

~~9. When the use of 100 percent outside air will cause coil frosting, controls may be added to reduce the quantity of outside air. However, the intent of this exception is to use 100 percent air in lieu of mechanical cooling when less energy usage will result and this exception applies only to direct expansion systems when the compressor(s) is running.~~

~~10. When the fan system will regularly be operated for less than 30 hours per week.~~

~~11. When the total design sensible cooling load is less than 6.8 Btu/h/ft.^{2} of floor area.~~

~~12. For single-family and multifamily residential buildings.~~))

503.7.1 Economizer controls

503.7.1.1: Each fan system shall be designed and capable of being controlled to take advantage of favorable weather conditions to reduce mechanical cooling requirements.

The system shall include either of the following:

(a) a temperature or enthalpy air economizer system which is capable of automatically modulating outside air and return air dampers to provide 85% or more of the design supply air quantity as outside air for cooling; or

(b) a water economizer system which is capable of cooling supply air by direct evaporation, indirect evaporation, or both. Such a system shall be designed and capable of being controlled to provide 100% of the expected system cooling load at outside air temperatures of 50 degrees F dry-bulb/ 45 degrees F wet-bulb and below. For this calculation, all factors including solar and internal loads shall be the same as those used for peak load calculations, except for the outside air temperatures.

Exceptions

1. Individual fan-cooling units with a supply capacity of less than 3000 cfm or a total cooling capacity less than 90,000 Btu/h. The total capacity of all such units complying by use of this exception shall not exceed 600,000 Btu/h per building or 10% of the total installed cooling capacity, whichever is larger.

2. Systems with air or evaporatively cooled condensers and for which one of the following is true:

   a. the system includes extensive filtering equipment provided in order to meet the requirements of 6.1.2 of ASHRAE Standard 62-1989.

   b. it can be shown that the use of outdoor air cooling affects the operation of other systems (such as humidification, dehumidification, and supermarket refrigeration systems) so as to increase overall building energy consumption.

3. The overall building energy consumption resulting from alternative designs, such as internal to external zone heat recovery systems, can be shown to be less than those resulting from an economizer system.

4. Systems that serve envelope dominated spaces whose sensible cooling load at design conditions, excluding transmission and infiltration loads, is less than or equal to transmission and infiltration losses at an outdoor temperature of 60 degrees F.

5. Systems serving residential spaces and hotel or motel rooms.

6. Systems for which at least 75% of the annual energy used for mechanical cooling is provided from a site-recovered or site-solar energy source.

7. The zone(s) served by the system each have operable openings (windows, doors, etc.) with an openable area greater than 5% of the conditioned floor area. This exception applies only to spaces open to and within 20 feet of the operable openings. Automatic controls shall be provided which lockout system mechanical cooling to these zones when outdoor air temperatures are less than 60 degrees F.

8. Hydronic heat pump systems in buildings which both have a breakeven outdoor temperature of 40 degrees F or lower and which are provided with a partial economizer cycle. The partial economizer cycle shall be capable of supplying outdoor air quantities equivalent to 100% of the total air supplied to meet the interior load at the design drybulb supply temperature but not less than 55 degrees F. The partial economizer shall be controlled based on outside air temperature and/or perimeter heating load.

503.7.1.2: Economizer systems shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

Exception: Direct expansion systems may include controls to reduce the quantity of outdoor air as required to prevent coil frosting at the lowest step of compressor unloading. Controls shall not cut economizer out of system when refrigeration system engages.

503.7.1.3: System design and economizer controls shall be such that economizer operation does not increase the building heating energy use during normal operation.

Exception: At least 75% of the energy for heating is provided from a site-recovered or site-solar energy source.

503.8 Controls

503.8.1 Temperature control: Each system shall be provided with at least one adjustable thermostat for the regulation of temperature. Each thermostat shall be capable of being set by adjustment or selection of sensors as follows:

503.8.1.1: When used to control heating only: 55 to 75 degrees F.

503.8.1.2: When used to control cooling only: 70 to 85 degrees F.

503.8.1.3: When used to control both heating and cooling, it shall be capable of being set from 55 to 85 degrees F. and shall be capable of operating the system heating and cooling in sequence. The thermostat and/or control system shall have an adjustable dead band of ((~~up to~~)) not less than 10 degrees F. ((~~or more except as allowed by the second subparagraph of Section 503.3.3.5.~~))

503.8.2 Humidity control: If a system is equipped with a means for adding moisture to maintain specific selected relative humidities in spaces or zones, a humidistat shall be provided. Humidistats shall be capable of being set to prevent new energy from being used to produce space-relative humidity above 30 percent. When a humidistat is used in a system for controlling moisture removal to maintain specific selected relative humidities in spaces or zones, it shall be capable of being set to prevent new energy from being used to produce a space-relative humidity less than 60 percent.

Exception: Special occupancies requiring different relative humidities may be permitted by the building official.

503.8.3 Zoning for temperature control

503.8.3.1 One- and two-family dwellings: At least one thermostat for regulation of space temperature shall be provided for each separate system. In addition, a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each zone or floor.

503.8.3.2 Multifamily dwellings: For multifamily dwellings, each individual dwelling unit shall have at least one thermostat for regulation of space temperature. A readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each room. Spaces other than living units shall meet the requirements of Section 503.8.3.3.

503.8.3.3 Other types of buildings or occupancies: At least one thermostat for regulation of space temperature shall be provided for:

° Each separate system.

° Each separate zone as defined in Chapter 2. As a minimum, each floor of a building shall be considered as a separate zone. In a multistory building where the perimeter system offsets only the transmission losses of the exterior wall, an entire side of uniform exposure may be zoned separately. A readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each floor.

503.8.3.4 Control setback and shutoff:

a. **Residential occupancy groups - One- and two-family and multifamily dwellings:** The thermostat required in Sections 503.8.3.1 and 503.8.3.2 or an alternate means, including, but limited to, a switch or a clock, shall provide a readily accessible manual or automatic means for reducing the energy required for heating and cooling during periods of non-use or reduced need including, but not limited to, unoccupied periods and sleeping hours. Lowering thermostat set points to reduce energy consumption of heating systems shall not cause energy to be expended to reach the reduced setting.

b. **Other** ((~~buildings and~~)) **occupancies:** Each system shall be equipped with a readily accessible automatic means of shutting off or reducing the energy used during periods of non-use or alternate uses of the building spaces or zones served by the system. Acceptable means include, but are not limited to:

° Manually adjusted automatic timing devices with a seven day minimum clock mechanism capable of being set for seven different day types per week;

((° ~~Manual devices for use by operating personnel; and~~))

° Automatic control systems.

Exceptions

1. For other than the dwelling unit portions of Group R Occupancy, systems serving areas expected to operate continuously at the same temperature setpoint.

2. Equipment with full load demands of 2 kW (6826 Btu/hr) or less may be controlled by readily accessible manual off-hour controls.

503.8.3.4.1: Outdoor air supply and exhaust systems shall be provided with motorized or gravity dampers or other means of automatic volume shutoff or reduction during periods of non-use or alternate use of the spaces served by the system.

Exceptions

1. Systems serving areas expected to operate continuously.

2. Gravity and other non-electrical ventilation systems may be controlled by readily accessible manual damper controls.

3. Where restricted by code such as at combustion air intakes.

503.8.3.4.2: Systems that serve zones which can be expected to operate non-simultaneously for more than 750 hours per year, including retail and restaurant areas in office buildings, shall include isolation devices and controls to shut off or set back the supply of heating and cooling to each zone independently. Isolation is not required for zones expected to operate continuously or expected to be inoperative only when all other zones are inoperative.

For buildings where occupancy patterns are not known at the time of system design such as speculative buildings, isolation areas may be predesignated.

Zones may be grouped into a single isolation area provided that the total conditioned floor area does not exceed 25,000 ft^2 per group nor include more than one floor.

503.8.3.5 Heat pump controls: Programmable thermostats are required for all heat pump systems. The cut-on temperature for the compression heating shall be higher than the cut-on temperature for the supplementary heat, and the cut-off temperature for the compression heating shall be higher than the cut-off temperature for the supplementary heat. Heat pump thermostats will be capable of providing at least two programmable setback periods per day. The automatic setback thermostat shall have the capability of limiting the use of supplemental heat during the warm-up period.

503.9 Air-handling duct system insulation: Ducts, plenums and enclosures installed in or on buildings shall be thermally insulated ((~~as follows:~~)) to meet the requirements of Table No. 5-11.

((~~503.9.1: Duct systems, or portions thereof, shall be installed to provide a thermal resistance, excluding film resistances, of:~~

$$R = \frac{\Delta t}{15} \text{ hr.·°F.·ft.}^2\text{/Btu}$$

~~where Δt = the design temperature differential between the air in the duct and the duct surface in degrees F.~~))

Exceptions: Duct insulation, except as required to prevent condensation, is not required in the following cases:

((~~1. When Δt is 25 degrees F or less.~~

~~2.~~))1. When supply- or return-air ducts are installed in basements, cellars or unventilated crawl spaces having insulated walls in one and two-family dwellings.

((~~3.~~))2. When the heat gain or loss of the ducts, without insulation, will not increase the energy requirements of the building.

((~~4.~~))3. Within HVAC equipment.

((~~5.~~))4. Exhaust air ducts.

((~~For residential buildings with uninsulated roofs over attics containing ducts, the air temperatures shown in Table No. 503.9.1 shall be used.~~))

(Table No. 503.9.1 is deleted.)

~~503.9.2:~~ Additional insulation with vapor barrier shall be provided to prevent condensation.

Exception: May be omitted when it can be demonstrated that condensation is not a problem.

(Table No. 5-11 is new and is not underlined.)

TABLE NO. 5-11 (Section 503.9)
INSULATION OF DUCTS

DUCT LOCATION	INSULATION TYPES MECHANICALLY COOLED	INSULATION TYPES HEATING ONLY	GROUP R OCCUPANCY HEATING OR COOLING DUCTS
On roof or on exterior of building	C and W	C and W	E and W
Attic, garage and crawl space, in walls[1], within floor-ceiling spaces[1]	B	B	E
Within the conditioned space or in basements and the temperature difference[2] is:			
° less than 15 degrees F	N.R.	N.R.	N.R.
° 15 to 40 degrees F	A	A	N.R.
° more than 40 degrees F	B	B	N.R.
In cement slab or in ground	A	B	B

Note: Requirements apply to both supply and return. Where ducts are used for both heating and cooling, the minimum insulation shall be as required for the most restrictive condition.

[1] See the requirements for ducts within the conditioned space for that portion of a duct which is located within a wall or floor-ceiling space where both sides of this space are exposed to conditioned air and where this space is not ventilated or otherwise exposed to unconditioned air.

[2] The temperature difference is that at design conditions between the space within which the duct is located and the design air temperature in the duct.

INSULATION TYPES: Minimum densities and out of package thickness. Nominal R-values are for the insulation as installed and do not include film resistance.

A. 1.0-inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber blanket or equivalent to provide an installed total thermal resistance of at 1east R-3.3.

B. 2-inch 0.60 lb/cu. ft. mineral or glass fiber blanket, 1.5-inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber blanket, 1.5-inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-5.

C. 3-inch 0.60 lb/cu. ft. mineral or glass fiber blanket 2-inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber blanket, 2-inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-7.

D. 4-inch 0.60 lb/cu. ft. mineral or glass fiber blanket, 3-inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber blanket, 3-inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-10.

E. 3.5 inch 0.60 lb/cu.ft. mineral or glass fiber blanket, 2.5 inch 1.5 to 2 lb/cu.ft. duct liner, mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-8.

W. Approved weatherproof barrier.

503.10 Duct construction: Ductwork shall be constructed and erected in accordance with Standards RS-15, RS-16, RS-17, RS-18, RS-19 or RS-20 listed in Chapter 7, ((~~or~~)) as applicable, and ((~~(~~))the Seattle Mechanical Code ((~~of the jurisdiction~~))).

503.10.1 Leakage tests: Group R Occupancy, high-pressure and medium-pressure ducts shall be leak tested in accordance with the applicable standards in Chapter 7 of this code with the rate of air leakage not to exceed the maximum rate specified in that standard.

For Other than Group R Occupancy, ductwork which is designed to operate at static pressures in excess of 3 in W.C. shall be leak tested and be in conformance with sections of the HVAC Duct Leakage Test Manual, as follows: the tested duct leakage class at a test pressure equal to the design duct pressure class rating shall be equal to or less than leakage class 6 as defined in 4.1 of Standard RS-18 listed in Chapter 7. Leakage testing may be limited to representative sections of the duct system but in no case shall such tested sections include less than 25% of the total installed duct area for the designated pressure class.

503.10.2 Additional sealing: For Group R Occupancy, when low-pressure supply air ducts are located outside of the conditioned space, ((~~except those located within return air plenums,~~)) all HVAC ductwork seams and joints, both longitudinal and transverse, ((~~joints~~)) shall be sealed ((~~using mastic, tape, or mastic plus tape. For fibrous glass ductwork, pressure-sensitive tape may be used.~~)) with products approved by the building official only. Ductwork joints shall be mechanically fastened with a minimum of three fasteners per joint for a cylindrical duct. See Table No. 5-11 for duct insulation requirements.

For Other than Group R Occupancy, where supply ductwork and plenums that are designed to operate at static pressures from 1/4 in. to 3 in. W.C. inclusive are located outside of the conditioned space or in return plenums, joints shall be sealed in accordance with Seal Class C as defined in the SMACNA manuals referenced above. Pressure sensitive tape shall not be used as the primary sealant where such ducts are designed to operate at static pressures of 1 in. W.C. or greater. All material used within the air plenum shall comply with the Seattle Mechanical Code. Duct leakage shall not exceed 10 percent of the air volume.

503.10.3: Automatic or manual dampers installed for the purpose of shutting off outside air intakes for ventilation air shall be designed with tight shutoff characteristics to minimize air leakage. See also the Seattle Building Code and the Seattle Mechanical Code.

503.11 Piping insulation: Piping installed to service buildings and within buildings shall be thermally insulated in accordance with Table No. 5-12 ((~~503.11~~)). For service water heating systems, see Section 504.

If water pipes are outside of conditioned space then the pipe insulation requirement shall be R-3 minimum for non-recirculating hot and cold water pipes. For recirculating service hot and cold water pipes see Table No. 5-12 for pipe sizes and temperatures.

Exceptions: Piping insulation is not required in the following cases:

1. Piping installed within HVAC equipment.

2. Piping at fluid temperatures between 55 degrees F and 105 ((~~120~~)) degrees F when not required for energy conservation purposes.

3. When the heat loss and/or heat gain of the piping without insulation does not increase the energy requirement of the building.

4. ((~~When piping is installed in basement, cellars or unventilated crawl spaces having insulated walls in one- and two-family dwelling~~)) Piping that conveys fluids which have not been heated or cooled through the use of fossil fuels or electricity.

(Table No. 503.11 is deleted.)

(Table No. 5-12 is new and is not underlined.)

TABLE NO. 5-12 (Section 503.11)
MINIMUM PIPE INSULATION (in)[1]

FLUID DESIGN OPERATING TEMPERATURE RANGE, °F	INSULATION CONDUCTIVITY Btu·in/h·ft²·°F CONDUCTIVITY RANGE	MEAN RATING TEMP°F	RUNOUTS[2]	NOMINAL PIPE DIAMETER (in.) 1 and less	>1 to 2	>2 to 4	>4 to 6	>6 and up
Heating Systems (Steam, Steam Condensate, and Hot Water)								
Above 350	0.32-0.34	250	1.5	2.5	2.5	3.0	3.5	3.5
251-350	0.29-0.31	200	1.5	2.0	2.5	2.5	3.5	3.5
201-250	0.27-0.30	150	1.0	1.5	1.5	2.0	2.0	3.5
141-200	0.25-0.29	125	0.5	1.5	1.5	1.5	1.5	1.5
105-140	0.24-0.28	100	0.5	1.0	1.0	1.0	1.5	1.5
Domestic and Service Hot Water Systems[3]								
105 and Greater	0.24-0.28	100	0.5	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine & Refrigerant)[4]								
40-55	0.23-0.27	75	0.5	0.5	0.75	1.0	1.0	1.0
Below 40	0.23-0.27	75	1.0	1.0	1.5	1.5	1.5	1.5

1 For minimum thicknesses of alternative insulation types, see Section 503.11.1.
2 Runouts to individual terminal units not exceeding 12 ft. in length with nominal pipe diameter not exceeding 2 inches.
3 Applies to recirculating sections of service or domestic hot water systems and, for other than Group R Occupancy, first 8 ft. from storage tank for non-recirculating systems.
4 The required minimum thicknesses of not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation.

503.11.1 Alternative insulation types: Insulation thicknesses in Table No. 5-12 are based on insulation with thermal conductivities within the range listed in Table No. 5-12 for each fluid operating temperature range, rated in accordance with ASTM C335-84 at the mean temperature listed in the table. For insulation that has a conductivity outside the range shown in Table No. 5-12 for the applicable fluid operating temperature range at the mean rating temperature shown (when rounded to the nearest 1/100th Btu inch/h·F·ft^2), the minimum thicknesses shall be determined in accordance with Equation 6.

EQUATION 6 (Section 503.11.1)

$$T = PR\ [(1 + th/PR)^{K/k} - 1]$$

Where:
T = minimum insulation thickness for material with conductivity K, in.
PR = pipe actual outside radius, in.
th = insulation thickness from Table No. 5-12, in.
K = conductivity of alternate material at the mean rating temperature indicated in Table No. 5-12 for the applicable fluid temperature range, Btu.in./(h·F·ft^2)
k = the lower value of the conductivity range listed in Table No. 5-12 for the applicable fluid temperature range, Btu.in./(h·F·ft^2)

((~~Other insulation thicknesses: Insulation thicknesses in Table No. 503.11 are based on insulation having thermal resistivity in the range of 4.0 to 4.6 h·ft.^{2}·°F./Btu per inch of thickness on a flat surface at a mean temperature of 75 degrees F.~~

~~Minimum insulation thickness shall be increased for materials having values less than 4.0, or may be reduced for materials having values greater than 4.6 as follows:~~

~~For materials with thermal resistivity greater than 4.6, the minimum insulation thickness may be reduced as follows:~~

$$\frac{\text{4.6 x Table No. 503.11 Thickness}}{\text{Actual Resistivity}} = \text{New Minimum Thickness}$$

~~For materials with thermal resistivity less than 4.0, the minimum insulation thickness shall be increased as follows:~~

$$\frac{\text{4.0 x Table No. 503.11 Thickness}}{\text{Actual Resistivity}} = \text{New Minimum Thickness}))$$

503.11.2: Additional insulation with vapor barriers shall be provided to prevent condensation((~~.~~)) unless

((~~Exception: Vapors barriers may be omitted when~~)) it can be demonstrated that condensation is not a problem.

Section 21: As of July 1, 1991, Section 504 of the 1989 Model Energy Code is amended, and Table No. 504.7 is deleted as follows:

SECTION 504 - SERVICE WATER HEATING

504.1 Scope: The purpose of this section is to provide criteria for design and equipment selection that will produce energy savings when applied to service water heating. Water supplies to ice-making machines and residential refrigerators shall be taken from a cold-water line of the water distribution system.

504.2 Water heaters, storage tanks and boilers

504.2.1 Performance efficiency: The thermal efficiency (energy factor) of water heaters shall not be less than the following:

(a) Gas water heater:	.62 -	(.0019 x rated storage volume in gallons)
(b) Oil water heater:	.59 -	(.0019 x rated storage volume in gallons)
(c) Electric water heater:	.95 -	(.00132 x rated storage in gallons)

The thermal efficiency of pool heaters shall not be less than 78 percent.

All water heaters shall meet the requirements of the 1987 National Appliance Energy Conservation Act and be so labeled.

All electric water heaters in unheated spaces or on concrete floors shall be placed on an incompressible, insulated surface with a minimum thermal resistance of R-10.

((~~504.2.1.1 Electric water heaters: Automatic electric storage water heaters having a storage capacity of 120 gallons or less and an input rating of 12kW or less shall have a standby loss not exceeding 4.0 watts/ft.^{2} of tank surface area or 43 watts, whichever is greater, when tested in accordance with Standard RS-5 listed in Chapter 7 and calculated at an 80 degrees F. temperature difference.~~

~~Automatic electric storage water heaters having either a storage capacity greater than 120 gallons or an input rate greater than 12kW shall have all waterbacked storage tank surfaces insulated to at least R-10 or have a standby loss not exceeding 4.0 watts/ft.^{2} when tested in accordance with Standard RS-6 listed in Chapter 7.~~

~~504.2.1.2 Gas- and oil-fired water heaters: Gas- and oil-fired automatic storage water heaters having an input rating of 75,000 Btu/h or less shall have a recovery efficiency (E_r) not less than 75 percent and standby loss (S) not exceeding:~~

~~$S = 2.3 + 67/V$~~

~~Where:~~

~~S = percent per hour of stored thermal energy~~

~~V = rated volume in gallons~~

~~These storage water heaters shall be tested in accordance with Standard RS-5 listed in Chapter 7.~~

~~Other gas-fired water heaters shall have a thermal efficiency (E_t) of not less than 75 percent when tested in accordance with Standard RS-7 listed in Chapter 7.~~

~~Gas- and oil-fired water heaters having an input rate over 75,000 Btu/h but less than 4,000 Btu/h per gallon of self-stored water shall also have a standby loss (S) not exceeding:~~

$$S = 2.8 + 67/V$$

~~Where:~~

~~S = percent per hour of stored thermal energy~~

~~V = rated volume in gallons~~

~~Natural gas- and oil-fired water heaters having an input rate of more than 4,000 Btu/h per gallon of stored water and having a pilot input rate greater than 0.5 percent of the maximum heater input rate (but not exceeding 750 Btu/h) shall be equipped with an ignition system which is not a continuously burning pilot light.~~))

504.2.2 Insulation: Heat loss from unfired hot-water storage tanks shall be limited to a maximum of ((~~13.6~~)) 9.6 Btu/h/ft.^{2} of external tank surface area. The design ambient temperature shall be no higher than 65 degrees F.

504.2.3 Combination service water heating/space heating equipment ((~~boilers~~)): Combination space and service water heating equipment may only be used when at least one of the following conditions is met:

(a) The annual space heating energy is less than 50% of the annual service water heating energy.

(b) The energy input or storage volume of the combined boiler or water heater is less than twice the energy input or storage volume of the smaller of the separate boilers or water heaters otherwise required.

(c) The combined system uses no more energy than separate systems that meet the requirements of Sections 503.4 and 504.2.

(d) Where the input to the combined boiler is less than 150,000 Btu/h.

Exception: For Group R Occupancy, service water-heating equipment shall not be dependent on year-round operation of space heating boilers; that is, boilers that have as another function winter space heating((~~.~~)) other than

((~~Exceptions~~))

1. Systems with service/space heating boilers having a standby loss (Btu/h) less than:

$$\frac{13.3\ pmd + 400}{n}$$

determined by the fixture count method where:

pmd = probable maximum demand in gallons/hour as determined in accordance with Chapter ((~~37~~)) 54 of Standard RS-11 listed in Chapter 7.

n = fraction of year when outdoor daily mean temperature exceeds 64.9 degrees F.

The standby loss is to be determined for a test period of 24-hour duration while maintaining a boiler water temperature of 90 degrees F. above an ambient of 60 to 90 degrees F. and a 5-foot stack on appliance.

2. For systems where the use of a single heating unit will lead to energy savings, such unit shall be utilized.

504.2.3.1: Service water heating equipment used to provide additional functions (e.g. space heating) as part of a combination (integrated) system shall comply with minimum performance requirements for water heating equipment.

504.3 Automatic controls: Service water-heating systems shall be equipped with automatic temperature controls capable of adjustment from ((~~the lowest~~)) 90 degrees F to the highest acceptable temperature settings for the intended use. Temperature setting range shall be in accordance with Table No. ((~~2~~)) 3 in Chapter ((~~37~~)) 54 of Standard RS-11 listed in Chapter 7. For Group R Occupancy, temperature setting range shall be set to 120 degrees F.

Exception: Service water heating systems serving residential dwelling units may be equipped with controls capable of adjustment down to 110 degrees F only.

504.3.1: Where temperatures higher than 120 degrees F are required at certain outlets for a particular intended use, separate remote heaters or booster heaters shall be installed for those outlets.

Exception: Where it can be shown that the energy used over the life of the equipment is not reduced.

504.3.2 Circulating hot water systems and heated pipes: Systems designed to maintain usage temperatures in hot water pipes, such as circulating hot water systems, shall be equipped with automatic time switches or other controls that can be set to turn off the system when use of hot water is not required.

504.4 Shutdown: A separate switch shall be provided to permit turning off the energy supplied to electric service water-heating systems. A separate valve shall be provided to permit turning off the energy supplied to the main burner(s) of all other types of service water heating systems.

504.5 Swimming pools

504.5.1: All pool heaters shall be equipped with an ON-OFF switch mounted for easy access to allow shutting off the operation of the heater without adjusting the thermostat setting and to allow restarting without relighting the pilot light. Controls shall be provided to allow the water temperature to be regulated from the maximum design temperature down to 65 degrees F.

504.5.2 Pool covers: Heated swimming pools shall be equipped with a pool cover, approved by the building official.

((~~Exception: Outdoor pools deriving over 20 percent of the energy for heating from nondepletable sources (computed over an operating season) are exempt from this requirement.~~))

504.5.3 Time clocks: Time clocks shall be installed so that the pump can be set to run in the off-peak electric demand period and can be set for the minimum time necessary to maintain the water in a clear and sanitary condition in keeping with applicable health standards.

504.6 Pump operation: Circulating hot-water systems shall be arranged so that the circulation pump(s) can be conveniently turned off, automatically or manually, when the hot-water system is not in operation.

504.7 Pipe insulation: For Group R Occupancy recirculating and non-recirculating systems, piping shall be thermally insulated in accordance with Section 503.11 and Table No. 5-12. For Other than Group R Occupancy see the requirements below. ((~~For recirculating systems piping heat loss shall be limited to a maximum of 17.5 Btu/h per linear foot of pipe in accordance with Table No. 504.7, which is based on design external temperature no lower than 65 degrees F. Other design temperatures must be calculated.~~

~~Exception: Piping insulation is not required when the heat loss of the piping, without insulation, does not increase the annual energy requirements of the building.~~))

504.7.1 Circulating systems: Piping insulation shall conform to the requirements of Table No. 5-12 or an equivalent level as calculated in accordance with Equation 6.

504.7.2 Non-circulating systems: The first 8 feet of outlet piping from a storage system that is maintained at a constant temperature and the inlet pipe between the storage tank and a heat trap shall be insulated as provided in Table No. 5-12 or to an equivalent level as calculated in accordance with Equation 6. Systems without a heat trap to prevent circulation due to natural convection shall be considered circulating systems.

(Table No. 504.7 is deleted.)

504.8 Conservation of hot water

504.8.1 Showers: Showers used for other than safety reasons shall ((~~be equipped with flow control devices to~~)) limit the maximum ((~~hot~~))water discharge to ((~~3~~)) 2.5 gpm as required by SHB 1397 and WAC 51-18 rated at distribution pressures from 20 to 80 psi when tested according to ANSI A112.18.1M-1989. Showerheads should not use flow restricting inserts to meet this criterion.

Exception: Until June 30, 1993, the maximum flow rate allowed is 3.0 gpm.

504.8.2: Lavatories in rest rooms of public facilities, including those in service stations, airports, train terminals and convention halls, shall meet all of the following requirements:

504.8.2.1: Be equipped with outlet devices which limit the flow of hot water to a maximum of ((~~0.5~~)) 2.5 gpm ((~~or~~)) and be equipped with self-closing valves as required by SHB 1397 and WAC 51-18 that limit delivery to a maximum of 0.25 gallons per cycle of hot water for ((~~re~~))circulating systems and to a maximum of 0.50 per cycle gallons for non-((~~re~~))circulating systems.

Exceptions:

1. Separate lavatories for physically handicapped persons ((~~shall~~)) need not be equipped with self-closing valves.

2. Until June 30, 1993, the maximum flow rate allowed is 3.0 gpm.

504.8.2.2: Be equipped with devices which limit the outlet temperature to a maximum of 110 degrees F.

504.8.3: All other bathroom, lavatory and kitchen faucets and replacement aerators shall limit the maximum discharge to 2.5 gallons per minute as required by SHB 1397 and WAC 51-18.

Exception: Until June 30, 1993, the maximum flow rate allowed is 3.0 gpm.

Section 22: As of July 1, 1991, Section 505 of the 1989 Model Energy Code is amended, Table Nos. 505.3.2.1a, 505.3.2.1b, 505.3.2.1c and 505.3.3.3 are deleted and Table No. 5-13 and Equations 7 and 8 are added as follows:

SECTION 505 - ELECTRICAL POWER AND LIGHTING

505.1 General: Electrical power and lighting systems shall be designed to conserve energy as provided herein.

505.2 Electrical energy consumption

505.2.1: ((~~In multifamily dwellings, provision shall be made to determine the electrical energy consumed by each tenant by separately metering individual dwelling units.~~

~~Exception: Motels, hotels, college dormitories and other transient facilities.~~))

505.2.2 Electrical motors: All permanently wired polyphase motors of 1 hp or more serving the building shall meet the requirements of 505.2.2. See Section 503.5 for requirements for variable speed control for HVAC systems.

505.2.2.1: Motors expected to operate more than 500 hours per year shall have a nominal full-load motor efficiency no less than the corresponding values for energy-efficient motors provided in NEMA MG1-12.54 and MG1-12.55.

505.2.2.2: The motor nameplates shall list the minimum nominal full-load motor efficiency.

505.3 Lighting power allowance ((~~budget~~)): A lighting power allowance ((~~budget~~)) is the upper limit of the power to be avail-

able to provide the lighting needs in accordance with the criteria and calculation procedure specified herein. Lighting wattage includes lamp and ballast wattage.

A building or facility total lighting power allowance will consist of the exterior lighting power allowance (ELPA) and the interior lighting power allowance (ILPA).

The exterior lighting power allowance (ELPA) shall be calculated in accordance with Section 505.3.4. The interior lighting power allowance (ILPA) shall be calculated in accordance with Section 505.3.2.

((~~The lighting power budget for a building shall be the sum of the power limits computed for all lighted interior and exterior spaces and shall be determined in accordance with the procedures specified in this section.~~))

Exception: One- and two-family detached dwellings and the dwelling portion of multifamily buildings are exempt from the requirements of Section 505.3. For other rooms, spaces, areas and lighting equipment which are exempt from the requirements, see Section 505.3.3.

505.3.1 Allowance ((~~budget~~)) development

505.3.1.1 Compliance: A building shall be considered in compliance with this section if all of the following conditions are met:

(a) the exterior lighting power to be installed is not greater than the exterior lighting power allowance based on Section 505.3.4

(b) the interior lighting power to be installed is not greater than the interior lighting power allowance based on Section 505.3.2.

The controls in the proposed design shall comply with the requirements in Section 505.4 and no credit towards compliance with the lighting power allowances shall be given for the use of any additional controls, automatic or otherwise.

Trade-off of interior lighting power allowance to gain exterior lighting power allowance is allowed. Trade-off of exterior lighting power allowance to gain interior lighting power allowance is NOT allowed. Trade-offs of the interior lighting power allowances among interior spaces are allowed within an individual tenant space only as long as the total connected lighting power for the entire individual tenant space does not exceed the interior lighting power allowance. Trade-offs of exterior lighting allowances among exterior areas are allowed as long as the total connected lighting power of exterior lighting does not exceed the exterior lighting power allowance.

((~~The criteria specified below shall be utilized for computation of lighting power budget. Calculations shall be in accordance with Section 505.3.5, Calculation Procedure.~~))

505.3.1.2: When insufficient information is known about the specific use of the building space (e.g., ((~~number of occupants,~~)) space function, ((~~location of partitions~~)) size of retail tenants), the ((~~budget~~)) allowance shall be based on the apparent intended use of the building space.

505.3.2 Building interiors: The interior lighting power allowance (ILPA) shall be calculated by multiplying the gross floor area (GFA), in square feet, by the appropriate unit lighting power allowance (ULPA), in watts per square foot, specified in Table No. 5-13. In cases where a lighting plan for only a portion of the floor is submitted, the interior lighting power allowances shall be based on the gross floor area covered by the plan. Partial plans for common areas only shall not exceed the unit lighting power allowance for common areas.

EQUATION 7 (Section 505.3.2)
ILPA = ULPA x GFA

Exception: In cases where a lighting plan for only a portion of a floor is submitted, the interior lighting power allowance (ILPA) may be based on the usable floor area (UFA) as defined by the Building Owners and Managers Association with a multiplier for a proportionate share of the common area and gross floor area (such as elevator space, lobby area, restrooms, exterior building wall thickness) and the interior lighting allowance may be calculated as follows:

EQUATION 8 (Section 505.3.2)
ILPA = ULPA x UFA x 1.1

Where lighting criteria are not listed in Table No. 5-13, the lighting power allowance shall be based upon the Seattle Building Code comparable occupancy type or as specified in the Illuminating Engineering Society Lighting Handbook Application Volume, latest edition.

((~~The allowable electric power for lighting shall be established by using the criteria and the calculation procedures specified in Section 505.3.5. The value shall be based on the use for which the space within the building is intended.~~

~~505.3.2.1 Illumination level criteria: For the purpose of establishing a budget, levels of illumination shall be those listed in Standard RS-8 listed in Chapter 7. Those levels shall be used as follows:~~

- ~~Task Lighting. In most cases, the levels of illumination listed are for specific tasks. These levels are for the task areas defined in Standard RS-8 listed in Chapter 7, or, where not defined, at all usable portions of task surfaces. In some cases, the levels of illumination are listed for locations. These levels are to be considered as average levels.~~

- ~~General Lighting. In areas surrounding task locations, the average level of general lighting, for budget purposes only, shall be one-third the level for the tasks performed in the area but in no case less than the level for the tasks performed in the area but in no case less than 20 footcandles. Where more than one task level occurs in a space, the general level shall be one-third the weighted average of the specific task levels.~~

- ~~Noncritical Lighting. In circulation and seating areas where no specific visual tasks occur, the average level of illumination shall be one-third of the average general lighting in the adjacent task spaces but in no case less than 10 footcandles.~~

~~Lighting System Criteria. For the purposes of establishing a power budget, only lamp efficiencies and coefficients of utilization (CU), specified in Table Nos. 505.3.2.1a and 505.3.2.1b, shall be assumed.~~))

(Tables Nos. 505.3.2.1a and 505.3.2.1b are deleted.)

(Table No. 5-13 is new and is not underlined.)

TABLE NO. 5-13 (Section 505.3.2)
UNIT LIGHTING POWER ALLOWANCE

OCCUPANCY DESCRIPTION[1]	**LIGHTING POWER ALLOWANCE**[2] (watts/ft^2)
Retail Stores[3]	
less than 6000 s.f.[4]	4.2
6000 to 20,000 s.f.	3.0
over 20,000 s.f.[10]	2.0
Sport tournament court (indoor)[5]	2.6
Painting, carpentry and machinery shops	2.3
Wholesale stores, laboratories, tailoring, barber and beauty parlor, hotel banquet/conference/exhibition hall[4,5]	2.0
Restaurant[6], bar[6], fastfood[6], cafeteria[6]	1.8
Libraries[6]	1.7
School buildings	1.5
Daycare centers, institutions[6], factories and workshops, handling and loading areas, welding shop, auto repair shop, gasoline service station, aircraft repair hangars	1.5
Mall concourse	1.4
Office buildings[6], administrative support areas[6], museums, hospitals, church/chapels, police and fire stations[7], banks[3,6,8]	1.35/1.5[9]
Laundry	1.3
Assembly[8], auditoriums, theatres, atrium, gymnasium, recreation	1.1
Process plants, locker room/shower room	1.0
Storage structures, warehouses	0.5
Aircraft storage hangers	0.4
Parking garages (indoor/outdoor)	See Section 505.3.4

Common Area Limits for Partial Floor Plan Submittals	
Common area corridor and lobby (except mall concourse), restrooms	0.9/1.0[9]

[1] In the case of an occupancy type not specifically mentioned, the unit lighting power allowance in watts per square foot shall be determined by the building official. Such determination shall be based upon the Seattle Building Code for the most comparable occupancy type specified. See Section 505.3.3 for exempt areas.

[2] Watts per square foot of room may be increased by two percent per foot of ceiling height above twenty feet except where other footnotes reference a different ceiling height.

[3] These allowances include all storage within the tenant space.

[4] Watts per square foot of room may be increased by two percent per foot of ceiling height above twelve feet.

[5] For all other spaces, such as seating and public areas, use the unit lighting power allowance for assembly.

[6] Watts per square foot of room may be increased by two percent per foot of ceiling height above nine feet.

[7] For the fire engine room, the unit lighting power allowance is 1.0 watts per square foot.

[8] Bank teller areas and airport ticket counter/inspection areas, such as customs baggage inspection, are allowed up to 2.5 watts per square foot.

[9] Where these uses are not located in building projects with a new construction area of fifty thousand (50,000) or more square feet of gross conditioned floor area of other than Group R Occupancy, the unit lighting power allowance is 1.5 watts per square foot. The common area limit for partial floor plan submittals shall be: 0.9 watts per square foot where the overall unit lighting power allowance is 1.35 watts per square foot; and, 1.0 watts per square foot in all other cases.

[10] For retail apparel and accessories, cosmetics, jewelry, china, crystal and similar areas in a department store setting, the unit lighting power allowance is 3.0 watts per square foot of those areas. This does not apply to general merchandise areas, such as food stuffs, hardware, books, sporting goods, consumer electronics, household goods, furniture or off-floor storage areas.

505.3.3 Exceptions to building interior and exterior criteria: Rooms, spaces, areas, and lighting equipment exempt from the lighting criteria in Section 505.3 include:

(a) Outdoor manufacturing, commercial greenhouses, and processing facilities.

(b) Lighting power for theatrical productions, television broadcasting (including sports facilities), audio-visual presentations, and those portions of entertainment facilities such as stage areas in hotel ballrooms, night clubs, discos, and casinos where lighting is an essential technical element for the function performed. Separate switching is required.

(c) Lighting in areas where medical and dental tasks are performed.

(d) Outdoor athletic facilities.

(e) Display lighting required for art exhibits, displays and inspection and restoration in galleries, museums and monuments.

(f) Exterior lighting for public monuments.

(g) Special lighting needs for research.

(h) Lighting to be used solely for indoor plant growth during the hours of 10:00 p.m. to 6:00 a.m.

(i) Emergency lighting that is automatically OFF during normal building operation.

(j) High risk security areas or any area identified by local ordinances or regulations or by security or safety officials as requiring additional lighting.

(k) Spaces specifically designed for primary use by the visually impaired, hard of hearing (lip-reading) or by senior citizens.

(l) Lighting for signs, walkways and pathways.

(m) Food preparation area.

(n) Plug in portable display fixtures, show case lighting and lighting that is part of machines, equipment or furniture.

(o) Electrical/mechanical equipment rooms.

((~~505.3.3.1: The criteria of 505.3.2 shall not apply to the following areas when calculating the load:~~

- ~~Residential-type spaces in institutions, such as hospitals, hotels, funeral homes, churches, museums, etc., other than kitchens, bathrooms, laundry areas and public spaces, including lobbies, halls, stairways, basement areas and utility rooms.~~

- ~~Theatre auditoriums, entertainment, audiovisual presentations and motion picture and television studios where the lighting is an essential technical element for the function performed.~~

~~505.3.3.2: The criteria of the fourth subparagraph of 505.3.2.1 shall not apply to the following lamps and luminaires; however, their use shall be accounted for in the calculation of task lighting loads for specific tasks. The allowable load shall be based on the luminaire wattage to achieve the levels of illumination as covered in Section 505.3.2 using the point calculation method given in Standard RS-8 listed in Chapter 7.~~

- ~~Luminaires for medical and dental purposes;~~

- ~~Luminaires for highlighting applications, such as sculpture exhibits, art exhibits, and individual items of display merchandise; and,~~

- ~~Luminaires for specialized lighting applications (color matching, where electrical interference cannot be tolerated, etc.).~~

~~505.3.3.3: The criteria of Table No. 505.3.3.3 shall not apply in spaces where it is impractical to control reflectances and where a dirty atmosphere cannot be avoided. Where this condition exists, the values for reflectances and light loss factors shall be those expected to be found and shall be approved by the building official. The calculation shall make note of this deviation.~~

(Table No. 505.3.3.3 is deleted.)

~~505.3.3.4: When the use of HID lamps under 250 W or fluorescent lamps under 40W is appropriate, a lamp efficacy of 25 lm/W shall be used.~~

~~Exception: A lamp efficacy of 55 lm/W shall be used when the following conditions exist:~~

- ~~The power budget exceeds 1 W/ft.^{2} in spaces under 500 ft.^{2}~~
- ~~The power budget exceeds 500 W in spaces between 500 and 1000 ft.^{2}~~
- ~~The power budget exceeds 0.5 W/ft.^{2} in spaces over 1000 ft.^{2}~~))

505.3.4 Building exteriors: In exterior spaces, the lighting power ((~~budget~~)) allowance shall be based on the use for which the space is intended. Tradeoff of interior lighting power allowance to gain exterior lighting power allowance is allowed. Tradeoff of exterior lighting power allowance to gain interior lighting power allowance is NOT allowed.

505.3.4.1: The exterior lighting allowance for other than residential uses, shall be calculated by multiplying the building facade area by 0.25 watts per square foot. Lighting for covered parking, open parking and outdoor uses shall be calculated at 0.20 watts per square foot.

((~~505.3.4.1 Criteria: The same criteria as those for interior spaces apply for illumination and lighting systems with the addition of luminaires for floodlighting. For power budget purposes, luminaires shall have a greater percentage of their beam lumens restricted to the area to be lighted and have minimum efficiencies at least as great as those listed in Standard RS-8 listed in Chapter 7.~~

~~505.3.4.2 Facade lighting: Facade lighting for budget purposes shall be no greater than 2 percent of the total interior load of the building.~~

~~505.3.4.3 Procedure: In establishing a lighting power budget the following procedures shall be used:~~

- ~~Overhead Lighting. The procedure specified in Section 505.3.5 shall be followed for overhead lighting, but using reflectances as found.~~
- ~~Floodlighting. The beam lumen method, as shown in Standard RS-8 listed in Chapter 7 and a coefficient of beam utilization (CBU) of 0.75 shall be used for floodlighting calculations.~~

505.3.5 Calculation Procedure: To establish a lighting power budget, the following procedures shall be used: determine illumination levels and areas; determine lighting system data; and determine allowable wattage.

505.3.5.1 Determining illumination levels and areas:

- Determine the visual tasks that are expected to be performed in each space (the commonly found tasks at each work station) and the number of planned work locations where tasks will be performed. If an assumption is made, its basis shall be indicated.

- Select the illumination level, in footcandles, for those expected tasks in accordance with the first subparagraph of 505.3.2.1.

- Calculate total task areas to be illuminated to the same level by multiplying the number of work locations by 50 $ft.^2$ per work location. (Total task area shall not exceed actual total space area.) If actual task area is greater than 50 $ft.^2$, actual area shall be used. If special task lighting or localized lighting is to be employed, use the actual task areas and point calculation procedures.

- Calculate the level of general lighting by multiplying the task lighting level by one third, where there is only one task level, or by taking one third of the sum of the products of the task levels and their areas divided by the total task areas in accordance with the second subparagraph of 505.3.2.1.

- Calculate the level of noncritical lighting in accordance with the third subparagraph of 505.3.2.1.

- For area determinations of general and noncritical lighting, calculations shall be based on B-3b, Attachment B, of Standard RS-9 listed in Chapter 7.

505.3.5.2 Determining lighting system data:

- Determine light source and luminaire types to use.

- Determine lamp lumens per watt and luminaire coefficients of utilization (CU's) for room luminaire mounting height dimensions. Luminaire CU's shall be selected from Standard RS-8 listed in Chapter 7 or manufacturers data for types not found in Standard RS-8. No luminaire shall have a CU less than required by Table No. 505.3.2.1b for the room cavity ratio calculated.

505.3.5.3 Determining allowable wattage:

- Using data from Section 505.3.5.2 above, the illumination levels and areas determined in Section 505.3.5.1 and the criteria of Table No. 505.3.3.3, calculate the allowable wattages using the lumen method.

- Calculate the total space wattage by adding the task, general and noncritical lighting loads.

- Add the wattage of luminaires allowed in Section 505.3.3.2.

~~505.4 Lighting switching: Switching shall be provided for each lighting circuit, or for portions of each circuit, so that the partial lighting required for custodial or for effective complementary use with natural lighting may be operated selectively.~~))

505.4 Lighting switching: Switching for building lighting systems shall be designed and installed to permit efficient use of energy and to permit maximum flexibility in the use of the installed lighting. The following mandatory requirements represent the minimum lighting controls to be installed in any building. Additional controls should be provided where deemed appropriate and where the installation of such controls can significantly reduce energy consumption.

The maximum lighting power that may be controlled from a single switch or automatic control shall not exceed that provided by a 20 ampere circuit loaded to not more than 80 percent. A master control may be installed provided the individual switches retain their capability to function independently.

505.4.1 Local control and accessibility: Each space enclosed by walls or ceiling-height partitions shall be provided with lighting controls located within that space. The lighting controls, whether one or more, shall be capable of turning off all lights within the space. The controls shall be readily accessible, at the point of entry/exit, to personnel occupying or using the space.

Exceptions: The following lighting controls may be centralized in remote locations:

1. Lighting controls for spaces which must be used as a whole.
2. Automatic controls.
3. Programmable controls.
4. Controls requiring trained operators.
5. Controls for safety hazards and security.

505.4.2 Daylighted zone control: All daylighted zones as defined in Chapter 2 both under skylights and adjacent to vertical glazing shall be provided with individual controls or daylight- or occupant-sensing automatic controls which permit control of lights independent of general area lighting.

505.4.3 Hotel and motel guest room controls: Hotel and motel guest rooms excluding bathrooms shall have one or more master switches at the main entry door that turn off all permanently wired lighting fixtures and switched receptacles. For multiple room hotel suites, switches at the entry of each room, in lieu of the switch at the main door, shall be acceptable to meet these requirements.

505.4.4 Exterior lighting controls: Exterior lighting not intended for 24-hour continuous use shall be automatically switched by timer, photocell, or a combination of timer and photocell. All time-controllers shall be equipped with backup provisions to keep time during power outage of at least four hours.

Section 23: As of July 1, 1991, Chapter 6 of the 1989 Model Energy Code is hereby repealed.

Section 24: As of July 1, 1991, Chapter 7 of the 1989 Model Energy Code is amended and Figure Nos. 1-13 are deleted as follows:

CHAPTER 7
STANDARDS

701.1: The standards, and portions thereof, which are referred to in various parts of this code ((~~shall be part of the Model Energy Code and~~)) are hereby declared to be part of this code.

CODE STANDARD NO.	TITLE AND SOURCE
RS-1	((~~1985~~))1989 ASHRAE Handbook, ((~~of~~)) Fundamentals Volume.
RS-2	Standard Method of Test for Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors, Specification E283-((~~73~~))84 of ASTM. Specifications for Aluminum Windows, ANSI A134.1, 1972. Specifications for Aluminum Sliding Glass Doors, ANSI A134.2, 1972. Industry Standard for Window Units, NW((~~M~~))WDA IS-2-87. Industry Standard for Wood Sliding Patio Doors, NW((~~M~~))WDA IS-3-88.
RS-3	ASHRAE Standard 62-((~~73 Natural and Mechanical Ventilation~~)) 1989 Ventilation for Acceptable Indoor Air Quality.
RS-4	ASHRAE Standard 55-((~~74~~))1981 Thermal Environmental Conditions for Human Occupancy.
RS-5	DOE Test Procedures for Water Heaters, 10 CFR Part 430 Appendix E to Subpart B.
RS-6	Household Automatic Electric Storage-Type Water Heaters, ANSI C72.1-72.
RS-7	Gas Water Heaters, Volume III, Circulating Tank, Instantaneous and Large Automatic Storage-Type Water Heaters, ANSI Z21.10.3-1974.
RS-8	IES Lighting Handbook, ((~~5th Edition, 1972~~)) 1984 Reference Volume, 1987 Application Volume, Illuminating Engineering Society.
RS-9	ASHRAE Standard ((~~90A-1980, Energy Conservation in New Building Design~~)) 90.1-1989, Energy Efficient Design of New Buildings Except New Low-Rise Residential Buildings.
RS-10	Standard for Packaged Terminal Air Conditioners, ARI Standard 310-((~~70~~))90.
RS-11	((~~1984~~)) 1987 ASHRAE Handbook HVAC Systems and Applications Volume.
RS-12	Energy Calculations I: Procedures for Determining Heating and Cooling Loads for Computerizing Energy Calculations--Algorithms for Building Heat Transfer Subsystems, ASHRAE 1975.

CODE STANDARD NO.	TITLE AND SOURCE
RS-13	Energy Calculations II: Procedures for Simulating the Performance of Components and Systems for Energy Calculations, 3rd Edition, ASHRAE 1975.
RS-14	Standard for Positive Displacement Refrigerant Compressor and Condensing Units, ARI Standard 520-74.
RS-15	((~~1983~~)) 1988 ASHRAE Handbook, Equipment Volume.
RS-16	Heating and Air Conditioning Systems--Installation Standards, SMACNA, February, 1977.
RS-17	SMACNA ((~~Low Pressure Duct Construction Standards, 5th Edition, Washington, D.C.~~)) HVAC Duct Construction Standards,--Metal and Flexible, Vienna, VA, 1985.
RS-18	SMACNA ((~~High Pressure Duct Construction Standards, 3rd Edition, Washington, D.C.~~)) Duct Leakage Test Manual, Vienna, VA, 1985.
RS-19	SMACNA Fibrous Glass Duct Construction Standards, ((~~5th~~)) 6th Edition, Washington, D.C., ((~~1979~~)) 1990.
RS-20	((~~1982~~)) 1990 ASHRAE Handbook, ((~~and Product Directory Applications~~)) Refrigeration Volume.
RS-21	Standard for Package Terminal Heat Pumps, ARI Standard 380-((~~78~~))90.
RS-22	((~~1988 DOE Building Foundation Design Handbook~~)) ASTM E779-87 Standard Practice for Measuring Air Leakage by the Fan Pressurization Method.
RS-23	ASTM E741 Standard Practice for Measuring Air Leakage by the Tracer Dilution Method.
RS-24	Standard 24 CFR Part 3280 HUD.
RS-25	Thermal Bridge in Sheet Metal Construction from Appendix E of RS-9.
RS-26	Super Good Cents Technical Reference.

ACCREDITED AUTHORITATIVE AGENCIES

AAMA refers to the American Architectural Manufacturers Association, 2700 River Road, Des Plaines, IL 60018.

ANSI refers to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ARI refers to the Air Conditioning and Refrigeration Institute, ((~~1815 North Fort Myer Drive~~)) 1501 Wilson Boulevard, Suite 600, Arlington, VA 22209.

ASHRAE refers to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329.

ASTM refers to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

DOE refers to the United States Department of Energy, Washington D.C., 20545.

IES refers to Illuminating Engineering Society, 345 East 47th Street, New York, NY 10017.

NESCA refers to the National Environmental System Contractors Association, 1501 Wilson Blvd., Arlington, VA 22209.

NW((M))WDA refers to the National ((~~Woodwork Manufacturers~~)) Wood Window and Door Association, Inc., ((~~400 Madison Avenue, Chicago, IL 60606~~)) 1400 E. Touhy Avenue, Suite G-54, Des Plaines, IL 60018.

SMACNA refers to the Sheet Metal and Air Conditioning Contractors National Association, Inc., 8224 Old Courthouse Rd., Tysons Corner, Vienna, VA 22180.

(Figure Nos. 1-13 are deleted.)

Section 25: As of July 1, 1991, the 1989 Model Energy Code is amended by adding a new Chapter 8 as follows:

CHAPTER 8

SUGGESTED SOFTWARE FOR CHAPTER 4 SYSTEMS ANALYSIS APPROACH FOR GROUP R OCCUPANCY

Program Name:	**Source**
CALPAS 3	BERKELEY SOLAR GROUP 455 Santa Clara Ave. Oakland, CA 94610 (415) 843-7600
DATACAL	SUNRISE ENERGY, INC. 5708 43rd Ave E. Tacoma, WA 98443 (206) 922-5218
DOE 2	ACROSOFT INTERNATIONAL, INC. 9745 E. Hampten Ave. Suite 230 Denver, CO 80231 (303) 368-9225
F-LOAD	F-CHART SOFTWARE 4406 Fox Bluff Rd. Middleton, WI 53562 (608) 836-8536
MICROPAS	ENERCOMP 123 C Street Davis, CA 95616 (916) 753-3400
SUNDAY	ECOTOPE 2812 East Madison St. Seattle, WA 98112 (206) 322-3753
WATTSUN	WASHINGTON STATE ENERGY OFFICE 809 Legion Way SE. Olympia, WA 98504 Attn: Hank Date (206) 956-2031

Section 26: As of July 1, 1991, the 1989 Model Energy Code is amended by adding a new Chapter 9 and Table Nos. 9-1, 9-2, 9-3a to 9-3j and 9-4 as follows:

CHAPTER 9

ASSUMPTIONS TO BE USED WITH CHAPTER 4 SYSTEMS ANALYSIS

The following requirements are based on Section 13 of ASHRAE Standard 90.1-1989 and addenda. They are similar but not identical to that standard.

Group R Occupancy shall comply with Section 402.6 without exception. In case of conflicts between Section 402.6 and Chapter 9, Section 402.6 shall govern.

SECTION 901 - DETERMINATION OF THE ANNUAL ENERGY CONSUMPTION

Annual energy consumption shall be determined in accordance with the general assumptions in Section 901.1 and either the prototype building method in Section 901.2 or the reference building method in Section 901.3.

901.1 General assumptions for both the prototype and reference building: The form, orientation, occupancy, and use profiles for a prototype or reference building shall be the same as the proposed design. Envelope, lighting, electrical systems, and HVAC systems shall meet the respective prescriptive or system performance requirements of Chapter 5 and are standardized inputs. For building projects with a new construction area of fifty thousand (50,000) or more square feet of gross conditioned floor area of other than Group R Occupancy, all HVAC Systems in the prototype and reference building shall have optimum start/stop controls.

901.2 Prototype building procedure: The prototype building procedure is an option for all building types listed below. For mixed-use buildings, the floor space of each building type is allocated within the floor space of the prototype building. For buildings not listed below, the reference building procedure of Section 901.2 shall be used. Prototype buildings include:

(a) assembly
(b) health/institutional
(c) hotel/motel
(d) light manufacturing
(e) multifamily
(f) office (business)
(g) restaurant
(h) retail (mercantile)
(i) school (educational)
(j) warehouse (storage).

901.2.1 Use of the prototype building to determine the energy consumption: The designer shall determine the building type of the proposed design using the categories presented in Section 901.2. Using the appropriate prototype building HVAC system characteristics from Table No. 9-4, the building shall be simulated.

901.3 Reference building procedure: The reference building procedure is acceptable for compliance but shall be used when the proposed design cannot be represented by one or a combination of the prototype buildings listed in Section 901.2 or the assumptions inherent in the prototype building description, such as occupancy and use-profiles, cannot reasonably be altered to accurately represent the proposed design.

901.3.1 Use of the reference building to determine the energy budget: The HVAC system and zoning of the reference building shall be as in the proposed design. The proposed design HVAC system shall comply with Section 503.

SECTION 902 - STANDARD CALCULATION PROCEDURE

The standard calculation procedure consists of methods and assumptions for calculating the Budget Energy Consumption (BECON) for the prototype or reference building and the Design Energy Consumption (DECON) of the proposed design. In order to maintain consistency between the BECON and the DECON, the input assumptions in this section shall be used.

"Prescribed" assumptions shall be used without variation. "Default" assumptions shall be used unless the designer can demonstrate that a different assumption better characterizes the building's use over its expected life. Any modification of a default assumption shall be used in modeling both the prototype or reference building and the proposed design unless the designer demonstrates a clear cause to do otherwise.

902.1 Orientation and shape: The prototype building and the reference building shall consist of the same number of stories and gross floor area for each story as the proposed design. Each floor shall be oriented exactly as the proposed design. The geometric form shall be the same as the proposed design.

902.2 Internal loads: Internal loads for single-family and multifamily buildings are presented in Table No. 9-1. These assumptions shall be prescribed assumptions. Internal loads for other building types shall be modeled as noted in the following parts of Section 902.2. The systems specified for calculating the BECON in Section 902.2 are intended only as constraints in calculating the BECON. They are not intended as requirements or recommendations for systems to be used in the proposed building or for the calculation of the DECON.

902.2.1 Occupancy: Occupancy schedules shall be default assumptions. The same assumptions shall be made in computing design energy consumption as were used in calculating the budget energy consumption. Occupancy levels vary by building type and time of day. Table No. 9-2 establishes the density presented as ft^2/person of conditioned floor area that will be used by each building type. Table No. 9-3 establishes the percentage of the people that are in the building by hours of the day for each building type.

902.2.2 Lighting: The interior lighting power allowance (ILPA) for calculating the BECON shall be determined from Section 505.3.2. The lighting power used to calculate the DECON shall be the actual lighting power of the proposed lighting design.

Lighting levels in buildings vary based on the type of uses within buildings, by area and by time of day. Table No. 9-3 con-

tains the lighting energy profiles which establish the percentage of the lighting load that is switched ON in each prototype or reference building by hour of the day. These profiles are default assumptions and can be changed if required when calculating the BECON to provide, for example, a 12 hour rather than an 8 hour work day or to reflect the use of automatic lighting controls. The lighting schedules used in the BECON and DECON shall be identical and shall reflect the type of controls to be installed in the proposed design. The controls in the proposed design shall comply with the requirements in Section 505.4 and no credit shall be given for the use of any additional controls, automatic or otherwise.

902.2.3 Receptacle: Receptacle loads and profiles are default assumptions. The same assumptions shall be made in calculating design energy consumption as were used in calculating the energy consumption budget. Receptacle loads include all general service loads that are typical in a building. These loads should include additional process electrical usage but exclude HVAC primary or auxiliary electrical usage. Table No. 9-2 establishes the density in W/ft^2 to be used. The receptacle energy profiles shall be the same as the lighting energy profiles in Table No. 9-3. This profile establishes the percentage of the receptacle load that is switched ON by hour of the day and by building type.

902.3 Envelope

902.3.1 Insulation and glazing: The insulation characteristics and glazing area of the prototype and reference building envelope shall be determined by using the component performance requirements from Table No. 5-1 for Group R Occupancy and the "20% glazing" case component performance requirements from Table No. 5-2 for Other than Group R Occupancy in Chapter 5, with no assumed overhangs, shading coefficient of 0.65 and light weight walls. The U-value of the fenestration shall be that specified for the appropriate space heating system type using the component performance requirements from Table No. 5-1 for Group R Occupancy and the "20% glazing" case component performance requirements from Table No. 5-2 for Other than Group R Occupancy in Chapter 5. The insulation characteristics and glazing area are prescribed assumptions for prototype and reference buildings for calculating the budget energy consumption (BECON). In the calculation of the design energy consumption (DECON) of the proposed design, the envelope characteristics of the proposed design shall be used.

902.3.2 Infiltration: For prototype and reference buildings, infiltration assumptions shall be equal to the proposed design building.

902.3.3 Envelope and ground absorptivities: For prototype and reference buildings, absorptivity assumptions shall be default assumptions for computing the budget energy consumption (BECON) and default assumptions for computing the design energy consumption (DECON). The solar absorptivity of opaque elements of the building envelope shall be assumed to be 70%. The solar absorptivity of ground surfaces shall be assumed to be 80% (20% reflectivity).

902.3.4 Window management: No draperies or blinds shall be modeled for the prototype and reference buildings. No draperies shall also be the default assumption for computing the design energy consumption (DECON).

Draperies or blinds may be modeled for the design energy consumption (DECON), if they are included on the plans. If they are manually operated, the DECON shall be calculated by assuming they are effective over one-half the glazed area in each zone.

902.3.5 Shading: For prototype and reference buildings and the proposed design, shading by permanent structures and terrain be taken into account for computing energy consumption whether or not these features are located on the building site. A permanent fixture is one that is likely to remain for the life of the proposed design.

902.4 HVAC systems and equipment: The specifications and requirements for the HVAC systems of prototype buildings shall be those in Table No. 9-4, HVAC systems of prototype buildings, and, for reference buildings, shall be the same HVAC system type as the proposed design. For the calculation of the design energy consumption (DECON), the HVAC systems and equipment of the proposed design shall be used. The systems presented in Table No. 9-4 are intended only as constraints in calculating the budget energy consumption (BECON). They are not intended as either requirements or recommendations for the systems to be used in the proposed building or for the calculation of the design energy consumption (DECON).

902.4.1 HVAC zones: HVAC zones for calculating the budget energy consumption (BECON) and design energy consumption (DECON) shall consist of at least four perimeter and one interior zone per floor, with at least one perimeter zone facing each orientation. The perimeter zones shall be fifteen feet in width or one-third the narrow dimension of the building when this dimension is between 30 and 45 feet inclusive or half the narrow dimension of the building when this dimension is less than thirty feet.

Exceptions

1. For multifamily buildings, there shall be at least one zone per dwelling unit.

2. Building types such as assembly or warehouse may be modeled as a single zone if there is only one space.

3. Thermally similar zones, such as those facing one orientation on different floors, may be grouped together for the purposes of either the BECON or DECON simulation.

902.4.2 Process equipment sizing: Process loads shall be modeled in calculating both the budget energy consumption (BECON) and the design energy consumption (DECON). The designer shall document the installation of process equipment and the size of process loads.

902.4.3 HVAC equipment sizing: The equipment shall be sized in accordance with the methods of Section 503 to include the capacity to meet the process loads. For calculating the design energy consumption (DECON), actual air flow rates and installed equipment size shall be used in the simulation. Equipment sizing in the simulation of the proposed design shall correspond to the equipment intended to be selected for the design and the designer shall not use equipment sized automatically by the simulation tool.

902.5 Service water heating: The service water heating loads for prototype buildings are defined in terms of Btu/person-hour in Table No. 9-2. The values in the table refer to energy content of the heated water. The service water heating loads from Table No. 9-2 are prescribed for multifamily buildings and default for all other buildings. The same service-water-heating load assumptions shall be made in calculating design energy consumption (DECON) as were used in calculating the budget energy consumption (BECON). The service water heating system for the prototype or reference building shall be modeled as closely as possible as if it were designed in accordance with the ASHRAE Handbook, 1987 HVAC Systems and Applications Volume and meeting all the requirements of Section 504. The Service Water Heating equipment type for the prototype or reference building shall be either natural gas (fuel oil if natural gas is not available at the site) or an electric heat pump. The same fuel or fuels shall be used in the prototype or reference building as are used in the proposed design.

Exception: If temperatures equal to or greater than 145 degrees F are required for a particular application, the type of service water heating equipment may be electric resistance.

902.6 Controls

902.6.1: All occupied conditioned spaces in prototype, reference, and proposed design buildings in all climates shall be simulated as being both heated and cooled.

Exceptions

1. If a building or portion of a building is to be provided with only heating or cooling, both the prototype or reference building and the proposed design shall be simulated using the same assumptions. If such an assumption is made for a prototype building, the analysis shall show that the building interiortemperature meets the comfort criteria of ANSI/ASHRAE 55-1981, at least 98% of the occupied hours during the year.

2. If warehouses are not intended to be mechanically cooled, both the BECON and DECON shall be modeled assuming no mechanical cooling.

902.6.2: Space temperature controls for the prototype or reference building, except single- and multifamily, shall be set at 70 degrees F for space heating and 75 degrees F for space cooling, with a deadband in accordance with Section 503.8. The system shall be OFF during off-hours according to the appropriate schedule in Table No. 9-3, except that the heating system shall cycle ON if any space should drop below the night setback setting 55 degrees F. There shall be no similar setpoint during the cooling season. Lesser deadband ranges may be used in calculating the DECON.

Exceptions

1. Setback shall not be modeled in determining either the BECON or DECON if setback is not realistic for the proposed design such as a facility being operated 24 hours/day. For instance health facilities need not have night setback during the heating season.

2. If deadband controls are not to be installed, the DECON shall be calculated with both heating and cooling thermostat setpoints set to the same value between 70 degrees F and 75 degrees F inclusive, assumed to be constant for the year.

902.6.3: When providing for outdoor air ventilation when calculating the BECON, controls shall be assumed to close the outside air intake to reduce the flow of outside air to 0.0 cfm during "setback" and "unoccupied" periods. Ventilation using inside air may still be required to maintain scheduled setback temperature. Outside air ventilation, during occupied periods, shall be as required by the Seattle Building Code and the Seattle Mechanical Code.

902.6.4: If humidification is to be used in the proposed design, the same level of humidification and system type shall be used in the prototype or reference building. If dehumidification requires subcooling of supply air, then reheat for the prototype or reference building shall be from recovered waste heat such as condenser waste heat.

TABLE NO. 9-1

ASSUMPTIONS FOR GROUP R OCCUPANCY ANALYSIS

See Section 402.6.

TABLE NO. 9-2 (Section 902)
ACCEPTABLE OCCUPANCY DENSITIES, RECEPTACLE POWER DENSITIES AND SERVICE HOT WATER CONSUMPTION[1]

BUILDING TYPE	OCCUPANCY DENSITY[2] Ft^2/Person (Btu/h·ft^2)	RECEPTABLE POWER DENSITY[3] Watts/Ft^2 (Btu/h·ft^2)	SERVICE HOT WATER QUANTITIES[4] Btu/h·person
Assembly	50 (4.60)	0.25 (0.85)	215
Health/ Institutional	200 (1.15)	1.0 (3.41)	135
Hotel/Motel	250 (0.92)	0.25 (0.85)	1,110
Light Manufacturing	750 (0.31)	0.2 (0.68)	225
Office	275 (0.84)	0.75 (2.56)	175
Parking Garage	N.A.	N.A.	N.A.
Restaurant	100 (2.30)	0.1 (0.34)	390
Retail	300 (0.77)	0.25 (0.85)	135
School	75 (3.07)	0.5 (1.71)	215
Warehouse	15000 (0.02)	0.1 (0.34)	225

[1] The occupancy densities, receptacle power densities and service hot water consumption values are from ASHRAE Standard 90.1-1989 and addenda.

[2] Values are in square feet of conditioned floor area per person. Heat generation in Btu per person per hour is 230 sensible and 190 latent. Figures in parentheses are equivalent Btu per hour per square foot.

[3] Values are in Watts per square foot of conditioned floor area. Figures in parentheses are equivalent Btu per hour per square foot. These values are the minimum acceptable. If other process loads are not input (such as for computers, cooking, refrigeration, etc.), it is recommended that receptacle power densities be increased until total process energy consumption is equivalent to 25% of the total.

[4] Values are in Btu per person per hour and were developed to be used with the occupancy density listed and the schedules which follow.

TABLE NO. 9-3a
ASSEMBLY OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	OFF	OFF	OFF	0	0	0	0	0	0
2 (1-2am)	0	0	0	5	5	5	OFF	OFF	OFF	0	0	0	0	0	0
3 (2-3am)	0	0	0	5	5	5	OFF	OFF	OFF	0	0	0	0	0	0
4 (3-4am)	0	0	0	5	5	5	OFF	OFF	OFF	0	0	0	0	0	0
5 (4-5am)	0	0	0	5	5	5	OFF	OFF	OFF	0	0	0	0	0	0
6 (5-6am)	0	0	0	5	5	5	ON	OFF	OFF	0	0	0	0	0	0
7 (6-7am)	0	0	0	40	5	5	ON	ON	ON	0	0	0	0	0	0
8 (7-8am)	0	0	0	40	30	30	ON	ON	ON	0	0	0	0	0	0
9 (8-9am)	20	20	10	40	30	30	ON	ON	ON	0	0	0	0	0	0
10 (9-10am)	20	20	10	75	50	30	ON	ON	ON	5	5	5	0	0	0
11 (10-11am)	20	20	10	75	50	30	ON	ON	ON	5	5	5	0	0	0
12 (11-12pm)	80	60	10	75	50	30	ON	ON	ON	35	20	10	0	0	0
13 (12-1pm)	80	60	10	75	50	65	ON	ON	ON	5	0	0	0	0	0
14 (1-2pm)	80	60	70	75	50	65	ON	ON	ON	5	0	0	0	0	0
15 (2-3pm)	80	60	70	75	50	65	ON	ON	ON	5	0	0	0	0	0
16 (3-4pm)	80	60	70	75	50	65	ON	ON	ON	5	0	0	0	0	0
17 (4-5pm)	80	60	70	75	50	65	ON	ON	ON	5	0	0	0	0	0
18 (5-6pm)	80	60	70	75	50	65	ON	ON	ON	0	0	0	0	0	0
19 (6-7pm)	20	60	70	75	50	65	ON	ON	ON	0	0	0	0	0	0
20 (7-8pm)	20	60	70	75	50	65	ON	ON	ON	0	65	65	0	0	0
21 (8-9pm)	20	60	70	75	50	65	ON	ON	ON	0	30	30	0	0	0
22 (9-10pm)	20	80	70	75	50	65	ON	ON	ON	0	0	0	0	0	0
23 (10-11pm)	10	10	20	25	50	5	ON	ON	ON	0	0	0	0	0	0
24 (11-12am)	0	0	0	5	5	5	OFF	OFF	OFF	0	0	0	0	0	0
Total/Day	710	750	700	1155	800	845	1800	1700	1700	70	125	115	0	0	0
Total/Week	50.50 hours			74.20 hours			124.00 hours			5.90 hours			0.00 hours		
Total/Year	2633 hours			3869 hours			6465 hours			308 hours			0 hours		

[1] Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE NO. 9-3b
HEALTH OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	0	0	0	10	10	5	ON	ON	ON	1	1	1	0	0	0
2 (1-2am)	0	0	0	10	10	5	ON	ON	ON	1	1	1	0	0	0
3 (2-3am)	0	0	0	10	10	5	ON	ON	ON	1	1	1	0	0	0
4 (3-4am)	0	0	0	10	10	5	ON	ON	ON	1	1	1	0	0	0
5 (4-5am)	0	0	0	10	10	5	ON	ON	ON	1	1	1	0	0	0
6 (5-6am)	0	0	0	10	10	5	ON	ON	ON	1	1	1	0	0	0
7 (6-7am)	0	0	0	10	10	5	ON	ON	ON	1	1	1	0	0	0
8 (7-8am)	10	10	0	50	20	5	ON	ON	ON	17	1	1	2	2	0
9 (8-9am)	50	30	5	90	40	10	ON	ON	ON	58	20	1	75	46	2
10 (9-10am)	80	40	5	90	40	10	ON	ON	ON	66	28	1	100	70	2
11 (10-11am)	80	40	5	90	40	10	ON	ON	ON	78	30	1	100	70	2
12 (11-12pm)	80	40	5	90	40	10	ON	ON	ON	82	30	1	100	70	2
13 (12-1pm)	80	40	5	90	40	10	ON	ON	ON	71	24	1	75	51	2
14 (1-2pm)	80	40	5	90	40	10	ON	ON	ON	82	24	1	100	51	2
15 (2-3pm)	80	40	5	90	40	10	ON	ON	ON	78	23	1	100	51	2
16 (3-4pm)	80	40	5	90	40	10	ON	ON	ON	74	23	1	100	51	2
17 (4-5pm)	80	40	0	30	40	5	ON	ON	ON	63	23	1	100	51	0
18 (5-6pm)	50	10	0	30	40	5	ON	ON	ON	41	10	1	100	25	0
19 (6-7pm)	30	10	0	30	10	5	ON	ON	ON	18	1	1	52	2	0
20 (7-8pm)	30	0	0	30	10	5	ON	ON	ON	18	1	1	52	0	0
21 (8-9pm)	20	0	0	30	10	5	ON	ON	ON	18	1	1	52	0	0
22 (9-10pm)	20	0	0	30	10	5	ON	ON	ON	10	1	1	28	0	0
23 (10-11pm)	0	0	0	30	10	5	ON	ON	ON	1	1	1	0	0	0
24 (11-12am)	0	0	0	10	10	5	ON	ON	ON	1	1	1	0	0	0
Total/Day	850	380	40	1060	550	160	2400	2400	2400	783	249	24	1136	540	16
Total/Week	46.70 hours			60.10 hours			168.00 hours			41.88 hours			62.36 hours		
Total/Year	2435 hours			3134 hours			8760 hours			2184 hours			3251 hours		

[1] Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE NO. 9-3c
HOTEL/MOTEL OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	90	90	70	20	20	30	ON	ON	ON	20	20	25	40	44	55
2 (1-2am)	90	90	70	15	20	30	ON	ON	ON	15	15	20	33	35	55
3 (2-3am)	90	90	70	10	10	20	ON	ON	ON	15	15	20	33	35	43
4 (3-4am)	90	90	70	10	10	20	ON	ON	ON	15	15	20	33	35	43
5 (4-5am)	90	90	70	10	10	20	ON	ON	ON	20	20	20	33	35	43
6 (5-6am)	90	90	70	20	10	20	ON	ON	ON	25	25	30	33	35	43
7 (6-7am)	70	70	70	40	30	30	ON	ON	ON	50	40	50	42	40	52
8 (7-8am)	40	50	70	50	30	40	ON	ON	ON	60	50	50	42	32	52
9 (8-9am)	40	50	50	40	40	40	ON	ON	ON	55	50	50	52	45	65
10 (9-10am)	20	30	50	40	40	30	ON	ON	ON	45	50	55	52	45	65
11 (10-11am)	20	30	50	25	30	30	ON	ON	ON	40	45	50	40	42	53
12 (11-12pm)	20	30	30	25	25	30	ON	ON	ON	45	50	50	51	60	60
13 (12-1pm)	20	30	30	25	25	30	ON	ON	ON	40	50	40	51	65	53
14 (1-2pm)	20	30	20	25	25	20	ON	ON	ON	35	45	40	51	65	51
15 (2-3pm)	20	30	20	25	25	20	ON	ON	ON	30	40	30	51	65	50
16 (3-4pm)	30	30	20	25	25	20	ON	ON	ON	30	40	30	51	65	44
17 (4-5pm)	50	30	30	25	25	20	ON	ON	ON	30	35	30	63	65	64
18 (5-6pm)	50	50	40	25	25	20	ON	ON	ON	40	40	40	80	75	62
19 (6-7pm)	50	60	40	60	60	50	ON	ON	ON	55	55	50	86	80	65
20 (7-8pm)	70	60	60	80	70	70	ON	ON	ON	60	55	50	70	80	63
21 (8-9pm)	70	60	60	90	70	80	ON	ON	ON	50	50	40	70	75	63
22 (9-10pm)	80	70	80	80	70	60	ON	ON	ON	55	55	50	70	75	63
23 (10-11pm)	90	70	80	60	60	50	ON	ON	ON	45	40	40	45	55	40
24 (11-12am)	90	70	80	30	30	30	ON	ON	ON	25	30	20	45	55	40
Total/Day	1390	1390	1300	855	785	810	2400	2400	2400	915	930	900	1217	1303	1287
Total/Week	96.40 hours			58.70 hours			168.00 hours			64.05 hours			86.75 hours		
Total/Year	5026 hours			3061 hours			8760 hours			3340 hours			4523 hours		

1 Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE NO. 9-3d
LIGHT MANUFACTURING OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
2 (1-2am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
3 (2-3am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
4 (3-4am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
5 (4-5am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
6 (5-6am)	0	0	0	10	5	5	OFF	OFF	OFF	8	8	7	0	0	0
7 (6-7am)	10	10	5	10	10	5	ON	ON	OFF	7	7	4	0	0	0
8 (7-8am)	20	10	5	30	10	5	ON	ON	OFF	19	11	4	35	16	0
9 (8-9am)	95	30	5	90	30	5	ON	ON	OFF	35	15	4	69	14	0
10 (9-10am)	95	30	5	90	30	5	ON	ON	OFF	38	21	4	43	21	0
11 (10-11am)	95	30	5	90	30	5	ON	ON	OFF	39	19	4	37	18	0
12 (11-12pm)	95	30	5	90	30	5	ON	ON	OFF	47	23	6	43	25	0
13 (12-1pm)	50	10	5	80	15	5	ON	ON	OFF	57	20	6	58	21	0
14 (1-2pm)	95	10	5	90	15	5	ON	ON	OFF	54	19	9	48	13	0
15 (2-3pm)	95	10	5	90	15	5	ON	ON	OFF	34	15	6	37	8	0
16 (3-4pm)	95	10	5	90	15	5	ON	ON	OFF	33	12	4	37	4	0
17 (4-5pm)	95	10	5	90	15	5	ON	ON	OFF	44	14	4	46	5	0
18 (5-6pm)	30	5	5	50	5	5	ON	ON	OFF	26	7	4	62	6	0
19 (6-7pm)	10	5	0	30	5	5	ON	OFF	OFF	21	7	4	20	0	0
20 (7-8pm)	10	0	0	30	5	5	ON	OFF	OFF	15	7	4	12	0	0
21 (8-9pm)	10	0	0	20	5	5	ON	OFF	OFF	17	7	4	4	0	0
22 (9-10pm)	10	0	0	20	5	5	ON	OFF	OFF	8	9	7	4	0	0
23 (10-11pm)	5	0	0	10	5	5	OFF	OFF	OFF	5	5	4	0	0	0
24 (11-12am)	5	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
Total/Day	920	200	60	1040	280	120	1600	1200	0	537	256	113	555	151	0
Total/Week	48.60 hours			56.00 hours			92.00 hours			30.54 hours			29.26 hours		
Total/Year	2534 hours			2920 hours			4797 hours			1592 hours			1526 hours		

1 Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE NO. 9-3e
OFFICE OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
2 (1-2am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
3 (2-3am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
4 (3-4am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
5 (4-5am)	0	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
6 (5-6am)	0	0	0	10	5	5	OFF	OFF	OFF	8	8	7	0	0	0
7 (6-7am)	10	10	5	10	10	5	ON	ON	OFF	7	7	4	0	0	0
8 (7-8am)	20	10	5	30	10	5	ON	ON	OFF	19	11	4	35	16	0
9 (8-9am)	95	30	5	90	30	5	ON	ON	OFF	35	15	4	69	14	0
10 (9-10am)	95	30	5	90	30	5	ON	ON	OFF	38	21	4	43	21	0
11 (10-11am)	95	30	5	90	30	5	ON	ON	OFF	39	19	4	37	18	0
12 (11-12pm)	95	30	5	90	30	5	ON	ON	OFF	47	23	6	43	25	0
13 (12-1pm)	50	10	5	80	15	5	ON	ON	OFF	57	20	6	58	21	0
14 (1-2pm)	95	10	5	90	15	5	ON	ON	OFF	54	19	9	48	13	0
15 (2-3pm)	95	10	5	90	15	5	ON	ON	OFF	34	15	6	37	8	0
16 (3-4pm)	95	10	5	90	15	5	ON	ON	OFF	33	12	4	37	4	0
17 (4-5pm)	95	10	5	90	15	5	ON	ON	OFF	44	14	4	46	5	0
18 (5-6pm)	30	5	5	50	5	5	ON	ON	OFF	26	7	4	62	6	0
19 (6-7pm)	10	5	0	30	5	5	ON	OFF	OFF	21	7	4	20	0	0
20 (7-8pm)	10	0	0	30	5	5	ON	OFF	OFF	15	7	4	12	0	0
21 (8-9pm)	10	0	0	20	5	5	ON	OFF	OFF	17	7	4	4	0	0
22 (9-10pm)	10	0	0	20	5	5	ON	OFF	OFF	8	9	7	4	0	0
23 (10-11pm)	5	0	0	10	5	5	OFF	OFF	OFF	5	5	4	0	0	0
24 (11-12am)	5	0	0	5	5	5	OFF	OFF	OFF	5	5	4	0	0	0
Total/Day	920	200	60	1040	280	120	1600	1200	0	537	256	113	555	151	0
Total/Week	48.60 hours			56.00 hours			92.00 hours			30.54 hours			29.26 hours		
Total/Year	2534 hours			2920 hours			4797 hours			1592 hours			1526 hours		

1 Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE NO. 9-3f
PARKING GARAGE OCCUPANCY

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load Wkdy	Sat	Sun	SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load Wkdy	Sat	Sun	SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load Wkdy	Sat	Sun	SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load Wkdy	Sat	Sun	SCHEDULE FOR ELEVATOR Percent of Maximum Load Wkdy	Sat	Sun
1 (12-1am)				100	100	100									
2 (1-2am)				100	100	100									
3 (2-3am)				100	100	100									
4 (3-4am)				100	100	100									
5 (4-5am)				100	100	100									
6 (5-6am)				100	100	100									
7 (6-7am)				100	100	100									
8 (7-8am)				100	100	100									
9 (8-9am)				100	100	100									
10 (9-10am)				100	100	100	Based						Included		
11 (10-11am)				100	100	100	on						with		
12 (11-12pm)	N.A.			100	100	100	likely			N.A.			other		
13 (12-1pm)				100	100	100	use						occupancies		
14 (1-2pm)				100	100	100									
15 (2-3pm)				100	100	100									
16 (3-4pm)				100	100	100									
17 (4-5pm)				100	100	100									
18 (5-6pm)				100	100	100									
19 (6-7pm)				100	100	100									
20 (7-8pm)				100	100	100									
21 (8-9pm)				100	100	100									
22 (9-10pm)				100	100	100									
23 (10-11pm)				100	100	100									
24 (11-12am)				100	100	100									
Total/Day				2400	2400	2400									
Total/Week				168.00 hours											
Total/Year				8760 hours											

TABLE NO. 9-3g
RESTAURANT OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	15	30	20	15	20	20	ON	ON	ON	20	20	25	0	0	0
2 (1-2am)	15	25	20	15	15	15	ON	ON	ON	15	15	20	0	0	0
3 (2-3am)	5	5	5	15	15	15	ON	ON	ON	15	15	20	0	0	0
4 (3-4am)	0	0	0	15	15	15	OFF	OFF	OFF	0	0	0	0	0	0
5 (4-5am)	0	0	0	15	15	15	OFF	OFF	OFF	0	0	0	0	0	0
6 (5-6am)	0	0	0	20	15	15	OFF	OFF	OFF	0	0	0	0	0	0
7 (6-7am)	0	0	0	40	30	30	OFF	OFF	OFF	0	0	0	0	0	0
8 (7-8am)	5	0	0	40	30	30	ON	OFF	OFF	60	0	0	0	0	0
9 (8-9am)	5	0	0	60	60	50	ON	OFF	OFF	55	0	0	0	0	0
10 (9-10am)	5	5	0	60	60	50	ON	ON	OFF	45	50	0	0	0	0
11 (10-11am)	20	20	10	90	80	70	ON	ON	ON	40	45	50	0	0	0
12 (11-12pm)	50	45	20	90	80	70	ON	ON	ON	45	50	50	0	0	0
13 (12-1pm)	80	50	25	90	80	70	ON	ON	ON	40	50	40	0	0	0
14 (1-2pm)	70	50	25	90	80	70	ON	ON	ON	35	45	40	0	0	0
15 (2-3pm)	40	35	15	90	80	70	ON	ON	ON	30	40	30	0	0	0
16 (3-4pm)	20	30	20	90	80	70	ON	ON	ON	30	40	30	0	0	0
17 (4-5pm)	25	30	25	90	80	60	ON	ON	ON	30	35	30	0	0	0
18 (5-6pm)	50	30	35	90	90	60	ON	ON	ON	40	40	40	0	0	0
19 (6-7pm)	80	70	55	90	90	60	ON	ON	ON	55	55	50	0	0	0
20 (7-8pm)	80	90	65	90	90	60	ON	ON	ON	60	55	50	0	0	0
21 (8-9pm)	80	70	70	90	90	60	ON	ON	ON	50	50	40	0	0	0
22 (9-10pm)	50	65	35	90	90	60	ON	ON	ON	55	55	50	0	0	0
23 (10-11pm)	35	55	20	50	50	50	ON	ON	ON	45	40	40	0	0	0
24 (11-12am)	20	35	20	30	30	30	ON	ON	ON	25	30	20	0	0	0
Total/Day	750	740	485	1455	1365	1115	2000	1800	1700	790	730	625	0	0	0
Total/Week	49.75 hours			97.55 hours			135.00 hours			53.05 hours			0.00 hours		
Total/Year	2594 hours			5086 hours			7039 hours			2766 hours			0 hours		

1 Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE 9-3h
RETAIL OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	OFF	OFF	OFF	4	11	7	0	0	0
2 (1-2am)	0	0	0	5	5	5	OFF	OFF	OFF	5	10	7	0	0	0
3 (2-3am)	0	0	0	5	5	5	OFF	OFF	OFF	5	8	7	0	0	0
4 (3-4am)	0	0	0	5	5	5	OFF	OFF	OFF	4	6	6	0	0	0
5 (4-5am)	0	0	0	5	5	5	OFF	OFF	OFF	4	6	6	0	0	0
6 (5-6am)	0	0	0	5	5	5	OFF	OFF	OFF	4	6	6	0	0	0
7 (6-7am)	0	0	0	5	5	5	ON	ON	OFF	4	7	7	0	0	0
8 (7-8am)	10	10	0	20	10	5	ON	ON	OFF	15	20	10	12	9	0
9 (8-9am)	20	20	0	50	30	10	ON	ON	ON	23	24	12	22	21	0
10 (9-10am)	50	50	10	90	60	10	ON	ON	ON	32	27	14	64	56	11
11 (10-11am)	50	60	20	90	90	40	ON	ON	ON	41	42	29	74	66	13
12 (11-12pm)	70	80	20	90	90	40	ON	ON	ON	57	54	31	68	68	35
13 (12-1pm)	70	80	40	90	90	60	ON	ON	ON	62	59	36	68	68	37
14 (1-2pm)	70	80	40	90	90	60	ON	ON	ON	61	60	36	71	69	37
15 (2-3pm)	70	80	40	90	90	60	ON	ON	ON	50	49	34	72	70	39
16 (3-4pm)	80	80	40	90	90	60	ON	ON	ON	45	48	35	72	69	41
17 (4-5pm)	70	80	40	90	90	60	ON	ON	ON	46	47	37	73	66	38
18 (5-6pm)	50	60	20	90	90	40	ON	ON	OFF	47	46	34	68	58	34
19 (6-7pm)	50	20	10	60	50	20	ON	ON	OFF	42	44	25	68	47	3
20 (7-8pm)	30	20	0	60	30	5	ON	ON	OFF	34	36	27	58	43	0
21 (8-9pm)	30	20	0	50	30	5	ON	ON	OFF	33	29	21	54	43	0
22 (9-10pm)	0	10	0	20	10	5	OFF	ON	OFF	23	22	16	0	8	0
23 (10-11pm)	0	0	0	5	5	5	OFF	OFF	OFF	13	16	10	0	0	0
24 (11-12am)	0	0	0	5	5	5	OFF	OFF	OFF	8	13	6	0	0	0
Total/Day	720	750	280	1115	985	525	1500	1600	900	662	690	459	844	761	288
Total/Week	46.30 hours			70.85 hours			100.00 hours			44.59 hours			52.69 hours		
Total/Year	2414 hours			3694 hours			5214 hours			2325 hours			2747 hours		

1 Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE NO. 9-3i
SCHOOL OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	OFF	OFF	OFF	5	3	3	0	0	0
2 (1-2am)	0	0	0	5	5	5	OFF	OFF	OFF	5	3	3	0	0	0
3 (2-3am)	0	0	0	5	5	5	OFF	OFF	OFF	5	3	3	0	0	0
4 (3-4am)	0	0	0	5	5	5	OFF	OFF	OFF	5	3	3	0	0	0
5 (4-5am)	0	0	0	5	5	5	OFF	OFF	OFF	5	3	3	0	0	0
6 (5-6am)	0	0	0	5	5	5	OFF	OFF	OFF	5	3	3	0	0	0
7 (6-7am)	0	0	0	5	5	5	OFF	OFF	OFF	5	3	3	0	0	0
8 (7-8am)	5	0	0	30	5	5	ON	OFF	OFF	10	3	3	0	0	0
9 (8-9am)	75	10	0	85	15	5	ON	ON	OFF	34	3	5	30	0	0
10 (9-10am)	90	10	0	95	15	5	ON	ON	OFF	60	5	5	30	0	0
11 (10-11am)	90	10	0	95	15	5	ON	ON	OFF	63	5	5	30	0	0
12 (11-12pm)	80	10	0	95	15	5	ON	ON	OFF	72	5	5	30	0	0
13 (12-1pm)	80	10	0	80	15	5	ON	ON	OFF	79	5	5	30	0	0
14 (1-2pm)	80	0	0	80	5	5	ON	OFF	OFF	83	3	5	30	0	0
15 (2-3pm)	80	0	0	80	5	5	ON	OFF	OFF	61	3	3	30	0	0
16 (3-4pm)	45	0	0	70	5	5	ON	OFF	OFF	65	3	3	15	0	0
17 (4-5pm)	15	0	0	50	5	5	ON	OFF	OFF	10	3	3	0	0	0
18 (5-6pm)	5	0	0	50	5	5	ON	OFF	OFF	10	3	3	0	0	0
19 (6-7pm)	15	0	0	35	5	5	ON	OFF	OFF	19	3	3	0	0	0
20 (7-8pm)	20	0	0	35	5	5	ON	OFF	OFF	25	3	3	0	0	0
21 (8-9pm)	20	0	0	35	5	5	ON	OFF	OFF	22	3	3	0	0	0
22 (9-10pm)	10	0	0	30	5	5	ON	OFF	OFF	22	3	3	0	0	0
23 (10-11pm)	0	0	0	5	5	5	OFF	OFF	OFF	12	3	3	0	0	0
24 (11-12am)	0	0	0	5	5	5	OFF	OFF	OFF	9	3	3	0	0	0
Total/Day	710	50	0	990	170	120	1500	500	0	691	80	84	285	0	0
Total/Week	36.00 hours			52.40 hours			80.00 hours			36.19 hours			14.25 hours		
Total/Year	1877 hours			2732 hours			4171 hours			1887 hours			743 hours		

1 Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE NO. 9-3j
WAREHOUSE OCCUPANCY[1]

HOUR OF DAY (Time)	SCHEDULE FOR OCCUPANCY Percent of Maximum Load			SCHEDULE FOR LIGHTING, RECEPTACLE Percent of Maximum Load			SCHEDULE FOR HVAC SYSTEM Percent of Maximum Load			SCHEDULE FOR SERVICE HOT WATER Percent of Maximum Load			SCHEDULE FOR ELEVATOR Percent of Maximum Load		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	OFF	OFF	OFF	2	2	2	0	0	0
2 (1-2am)	0	0	0	5	5	5	OFF	OFF	OFF	2	2	2	0	0	0
3 (2-3am)	0	0	0	5	5	5	OFF	OFF	OFF	2	2	2	0	0	0
4 (3-4am)	0	0	0	5	5	5	OFF	OFF	OFF	2	2	2	0	0	0
5 (4-5am)	0	0	0	5	5	5	OFF	OFF	OFF	5	2	2	0	0	0
6 (5-6am)	0	0	0	5	5	5	OFF	OFF	OFF	7	2	2	0	0	0
7 (6-7am)	0	0	0	5	5	5	OFF	OFF	OFF	7	2	2	0	0	0
8 (7-8am)	15	0	0	40	5	5	ON	OFF	OFF	10	2	2	0	0	0
9 (8-9am)	70	20	0	70	8	5	ON	ON	OFF	30	6	2	0	0	0
10 (9-10am)	90	20	0	90	24	5	ON	ON	OFF	36	12	2	0	0	0
11 (10-11am)	90	20	0	90	24	5	ON	ON	OFF	36	12	2	30	0	0
12 (11-12pm)	90	20	0	90	24	5	ON	ON	OFF	46	17	2	0	0	0
13 (12-1pm)	50	10	0	80	5	5	ON	ON	OFF	57	4	4	0	0	0
14 (1-2pm)	85	10	0	90	5	5	ON	ON	OFF	43	4	4	0	0	0
15 (2-3pm)	85	10	0	90	5	5	ON	ON	OFF	38	2	2	0	0	0
16 (3-4pm)	85	10	0	90	5	5	ON	ON	OFF	40	2	2	40	0	0
17 (4-5pm)	20	0	0	90	5	5	ON	OFF	OFF	30	2	2	0	0	0
18 (5-6pm)	0	0	0	30	5	5	OFF	OFF	OFF	18	2	2	0	0	0
19 (6-7pm)	0	0	0	5	5	5	OFF	OFF	OFF	3	2	2	0	0	0
20 (7-8pm)	0	0	0	5	5	5	OFF	OFF	OFF	3	2	2	0	0	0
21 (8-9pm)	0	0	0	5	5	5	OFF	OFF	OFF	3	2	2	0	0	0
22 (9-10pm)	0	0	0	5	5	5	OFF	OFF	OFF	3	2	2	0	0	0
23 (10-11pm)	0	0	0	5	5	5	OFF	OFF	OFF	3	2	2	0	0	0
24 (11-12am)	0	0	0	5	5	5	OFF	OFF	OFF	3	2	2	0	0	0
Total/Day	680	120	0	915	180	120	1000	800	0	429	91	52	70	0	0
Total/Week	35.20 hours			48.75 hours			58.00 hours			22.88 hours			3.50 hours		
Total/Year	1835 hours			2542 hours			3024 hours			1193 hours			182 hours		

1 Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addenda except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE NO. 9-4
HVAC SYSTEMS OF PROTOTYPE BUILDINGS[2]

BUILDING/SPACE OCCUPANCY	SYSTEM NO.	REMARKS
1. Assembly		
a. Churches (any size)	1	
b. $\leq$ 50,000 ft^2 or $\leq$ 3 floors	1 or 3	Note 1
c. > 50,000 ft^2 or > 3 floors	3	
2. Health		
a. Nursing home (any size)	2	
b. $\leq$ 15,000 ft^2	1	
c. > 15,000 ft^2 and $\leq$ 50,000 ft^2	4	Note 2
d. > 50,000 ft^2	5	Note 2, 3
3. Hotel/Motel		
a. $\leq$ 3 stories	2	Note 5
b. > 3 stories	6	Note 6
4. Light Manufacturing	1 or 3	
5. Office		
a. $\leq$ 20,000 ft^2	1	
b. > 20,000 ft^2 and either $\leq$ 3 floors or $\leq$ 75,000 ft^2	4	
c. > 75,000 ft^2 or > 3 floors	5	
6. Restaurant	1 or 3	Note 1
7. Retail		
a. $\leq$ 50,000 ft^2	1 or 3	Note 1
b. > 50,000 ft^2	4 or 5	Note 1
8. Schools		
a. $\leq$ 75,000 ft^2 or $\leq$ 3 floors	1	
b. > 75,000 ft^2 or > 3 floors	3	
9. Warehouse		Note 4

Footnote to Table No. 9-4: The systems and energy types presented in this table are not intended as requirements or recommendations for the proposed design. Floor areas in the table are the total conditioned floor areas for the listed occupancy type in the building. The number of floors indicated in the table is the total number of occupied floors for the listed occupancy type.

TABLE NO. 9-4 (cont.)
HVAC SYSTEM DESCRIPTIONS FOR PROTOTYPE AND REFERENCE BUILDINGS[a,b]

HVAC COMPONENT	SYSTEM #1	SYSTEM #2
System Description	Packaged rooftop single zone, one unit per zone	Packaged terminal air conditioner with space heater or heat pump, heating or cooling unit per zone
Fan System Design supply circulation rate	Note 9	Note 10
Supply fan control	Constant volume	Fan cycles with call for heating or cooling
Return fan control	N.A.	N.A.
Cooling System	Direct expansion air cooled	Direct expansion air cooled
Heating System	Furnace, heat pump, or electric resistance	Heat pump with electric resistance auxillary or air conditioner with space heater
Remarks	Drybulb economizer per Section 503.7 (barometric relief), heat recovery if required by Section 503.3.4.	No economizer, if not required by Section 503.7

Footnotes to Table No. 9-4:

a. The systems and energy types presented in this Table are not intended as requirements or recommendations for the proposed design.

b. For numbered notes see end of Table.

TABLE NO. 9-4 (cont.)
HVAC SYSTEM DESCRIPTIONS FOR PROTOTYPE AND REFERENCE BUILDINGS[a,b]

HVAC COMPONENT	SYSTEM #3	SYSTEM #4
System Description	Air handler per zone with central plant	Packaged rooftop VAV with perimeter reheat and fan-powered terminal units
Fan System Design supply circulation rate	Note 9	Note 9
Supply fan control	Constant volume	VAV with forward curved centrifugal fan and variable inlet vanes
Return fan control	Constant volume	VAV with forward curved centrifugal fan and discharge dampers
Cooling System	Chilled water (Note 11)	Direct expansion air cooled
Heating System	Hot water (Note 12)	Hot water (Note 12) or electric resistance
Remarks	Dry bulb economizer per Section 503.7, heat recovery if required by Section 503.3.4	Dry bulb economizer per Section 503.7 Minimum VAV setting per Section 503.3.2 Exception 1, Supply air reset by zone of greatest cooling demand.

Footnotes to Table No. 9-4

a. The systems and energy types presented in this Table are not intended as requirements or recommendations for the proposed design.

b. For numbered notes see end of Table.

TABLE NO. 9-4 (cont.)
HVAC System Descriptions for Prototype and Reference Buildings[a,b]

HVAC COMPONENT	SYSTEM #5	SYSTEM #6
System Description	Built-up central VAV with perimeter reheat and fan-powered terminal units	Four-pipe fan coil per zone with central plant
Fan System		
Design supply circulation rate	Note 9	Note 9
Supply fan	VAV with air-foil centrifugal fan and AC frequency variable speed drive	Fan cycles with call for heating or cooling
Return fan control	VAV with air-foil centrifugal fan and AC frequency variable speed drive	N.A.
Cooling System	Chilled water (Note 11)	Chilled water (Note 11)
Heating System	Hot water (Note 12) or electric resistance	Hot water (Note 12) or electric resistance
Remarks	Drybulb economizer per Section 503.7 Minimum VAV setting per Section 503.3.2 Exception 1 Supply air reset by zone of greatest cooling demand.	No economizer, if not required by Section 503.7

Footnotes to Table No. 9-4:

a. The systems and energy types presented in this Table are not intended as requirements or recommendations for the proposed design.

b. For numbered notes see end of Table.

TABLE NO. 9-4 (cont.)
HVAC System Descriptions for Prototype and Reference Buildings[a,b]

HVAC COMPONENT	SYSTEM#7
System Description	Water source heat pump
Fan System Design supply circulation rate	Note 10
Supply fan	Fan cycles with control call for heating or cooling
Return fan control	N.A.
Cooling System	Closed circuit, centrifugal blower type cooling tower sized per Note 11. Circulating pump sized for 2.7 gpm per ton.
Heating System	Electric or natural draft fossil fuel boiler
Remarks	Tower fans and boiler cycled to maintain circulating water temperature between 60 degrees F and design tower leaving water temperature.

Footnotes to Table No. 9-4:

a. The systems and energy types presented in this Table are not intended as requirements or recommendations for the proposed design.

b. For numbered notes see end of Table.

Numbered Footnotes for Table No. 9-4

HVAC System Descriptions for Prototype Buildings

1. For occupancies such as restaurants, assembly and retail that are part of a mixed use building which, according to Table No. 9-4, includes a central chilled water plant (systems 3, 5, or 6), chilled water system type 3 or 5 shall be used as indicated in the table.

2. Constant volume may be used in zones where pressurization relationships must be maintained by code. Where constant volume is used, the system shall have heat recovery if required by Section 503.3.4. VAV shall be used in all other areas, in accordance with Section 503.

3. Provide run-around heat recovery systems for all fan systems with minimum outside air intake greater than 75%. Recovery effectiveness shall be 0.60.

4. If a warehouse is not intended to be mechanically cooled, both the BECON and DECON may be calculated assuming no mechanical cooling.

5. The system listed is for guest rooms only. Areas such as public areas and back-of-house areas shall be served by system 4. Other areas such as offices and retail shall be served by the systems listed in Table No. 9-4 for these occupancy types.

6. The system listed is for guest rooms only. Areas such as public areas and back-of-house areas shall be served by system 5. Other areas such as offices and retail shall be served by the systems listed in Table No. 9-4 for these occupancy types.

7. Reserved.

8. Reserved.

9. Design supply air circulation rate shall be based on a supply-air-to-room air temperature difference of 20 degrees F. A higher supply air temperature may be used if required to maintain a minimum circulation rate of 4.5 air changes per hour or 15 cfm per person to each zone served by the system, at design conditions. If return fans are specified, they shall be sized for the supply fan capacity less the required minimum ventilation with outside air, or 75% of the supply fan capacity, whichever is larger. Except where noted, supply and return fans shall be operated continuously during occupied hours.

10. Fan energy when included in the efficiency rating of the unit as defined in Section 503.4, need not be modeled explicitly for this system. The fan shall cycle with calls for heating or cooling.

11. Chilled water systems shall be modeled using a reciprocating chiller for systems with total cooling capacities less than 175 tons, and centrifugal chillers for systems with cooling capacities of 175 tons or greater. For systems with cooling capacities of 600 tons or more the BECON shall be calculated using two centrifugal chillers, lead/lag controlled. Chilled water shall be assumed to be controlled at a constant 44 degrees F. Chiller water pumps shall be sized using a 12 degrees F temperature rise, from 44 degrees F to 56 degrees F, operating at 65% combined impeller and motor effeciency.

Numbered Footnotes for Table No. 9-4 (cont.)

HVAC System Descriptions for Prototype Buildings

Condenser water pumps shall be sized using a 10 degrees F temperature rise, operating at 60% combined impeller and motor efficiency. The cooling tower shall be an open circuit, centrifugal blower type sized for the larger of 85 degrees F leaving water temperature or 10 degrees F approach to design wetbulb temperature. The tower shall be controlled to provide a 65 degrees F leaving water temperature whenever weather conditions permit, floating up to design leaving water temperature at design conditions. Chilled water supply temperature shall be reset in accordance with Section 503.3.3.2.

12. Hot water system shall include a natural draft fossil fuel or electric boiler. The hot water pump shall be sized based on a 30 degrees F temperature drop, from 180 degrees F to 150 degrees F, operating at a combined impeller and motor efficiency of 60%. Hot water supply temperature shall be reset in accordance with Section 503.3.3.2.

Section 27: As of July 1, 1991, the 1989 Model Energy Code is amended by adding a new Chapter 10 and Table Nos. 10-A and 10-1 to 10-10 as follows:

CHAPTER 10

DEFAULT HEAT-LOSS COEFFICIENTS

SECTION 1001 - GENERAL

1001.1 Scope: This Appendix includes tables of seasonal average heat-loss coefficients for specified nominal insulation. The heat-loss coefficients may also be used for heating system sizing.

1001.2 Description: These coefficients were developed primarily from data and procedures from Standard RS-1 and taken specifically from Standard RS-26 listed in Chapter 7.

Coefficients not contained in this Chapter may be computed using the procedures listed in these references if the assumptions in the following sections and Standard RS-26 listed in Chapter 7 are used, along with data from the sources referenced above. Calculations using information from "Catalog of Thermal Bridges in Commercial and Multifamily Residential Construction" published by Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (ORNL/Sub/88-SA407/1), December 1989 are also acceptable. This publication provides a list of typical thermal bridges and offers examples of better construction practices which will improve energy performance.

1001.3 Compression of insulation: Insulation which is compressed shall be derated in accordance with Table No. 10-A or the reduction in value may be calculated in accordance with the procedures in Standard RS-1 listed in Chapter 7.

TABLE NO. 10-A (Section 1001.3)
R-VALUE OF FIBERGLASS BATTS THAT ARE COMPRESSED IN VARIOUS DEPTH CAVITIES

NOMINAL LUMBER SIZES	ACTUAL DEPTH OF CAVITY	INSULATION R-VALUE AT STANDARD THICKNESS[1]										
		38	30	22	21	19	15	13	11	8	5	3
		Insulation "R" Values When Installed In A Confined Cavity										
2" x 12"	11-1/4"	37	--	--	--	--	--	--	--	--	--	--
2" x 10"	9-1/4"	32	30	--	--	--	--	--	--	--	--	--
2" x 8"	7-1/4"	27	26	--	--	--	--	--	--	--	--	--
2" x 6"	5-1/2"	--	21	20	21	18	--	--	--	--	--	--
2" x 4"	3-1/2"	--	--	14	--	13	15	12.7	11	--	--	--
2" x 3"	2-1/2"	--	--	--	--	--	--	9.8	--	--	--	--
2" x 2"	1-1/2"	--	--	--	--	--	--	6.3	6.0	5.7	--	--
2" x 1"	1-1/2"	--	--	--	--	--	--	--	--	--	3.2	3.0

[1] The standard thicknesses are as follows: 12" for R-38, 9-1/2" for R-30, 6-3/4" for R-22, 3-5/8" for R-13, 2-1/2" for R-8, 1-1/2" for R-5, 3/4" for R-3.

SECTION 1002 - BELOW GRADE WALLS AND SLABS

1002.1 General: Table No. 10-1 lists heat-loss coefficients for below-grade walls and floors.

Coefficients for below-grade walls are given as U-values (BTU/°F-hr per square foot of wall area). Coefficients for below slabs are listed as F-values (BTU/°F-hr per lineal foot of slab perimeter).

Below-grade wall U-values are only valid when used with the accompanying below-grade slab F-value, and vice versa.

1002.2 Component description: All below-grade walls are assumed to be 8-inch concrete. The wall is assumed to extend from the slab upward to the top of the mud sill for the distance specified in Table No. 10-1, with 6 inches of concrete wall extending above grade.

Interior insulation is assumed to be fiberglass batts placed in the cavity formed by 2x4 framing on 24-inch centers with 1/2-inch of gypsum board as the interior finish material. Exterior insulation is assumed to be applied directly to the exterior of the below-grade wall from the top of the wall to the footing. The exterior case does not assume any interior framing or sheetrock.

In all cases, the entire wall surface is assumed to be insulated to the indicated nominal level with the appropriate framing and insulation application. Coefficients are listed for wall depths of 2, 3.5, and 7 feet below grade. Basements shallower than 2 feet should use on-grade slab coefficients.

Heat-loss calulations for wall areas above grade should use above-grade wall U-values, beginning at the mudsill.

1002.3 Insulation description: Coefficients are listed for the following four configurations:

a. **Uninsulated:** No insulation or interior finish.

b. **Interior insulation:** Interior 2x4 insulated wall without a thermal break between concrete wall and slab.

c. **Interior insulation w/thermal break:** Interior 2x4 insulated wall with R-5 rigid board providing a thermal break between the concrete wall and the slab.

d. **Exterior insulation:** Insulation applied directly to the exterior surface of the concrete wall.

TABLE NO. 10-1 (Section 1002)
DEFAULT WALL U-VALUES AND SLAB F-VALUES FOR BASEMENTS

	Below Grade Wall U-Value	Below Grade Slab F-Value
2-Foot Depth Below Grade		
Uninsulated	0.350	0.59
R-11 Interior	0.066	0.68
R-11 Interior w/tb	0.070	0.60
R-19 Interior	0.043	0.69
R-19 Interior	0.045	0.61
R-10 Exterior	0.070	0.60
R-12 Exterior	0.061	0.60
3.5-Foot Depth Below Grade		
Uninsulated	0.278	0.53
R-11 Interior	0.062	0.63
R-11 Interior w/tb	0.064	0.57
R-19 Interior	0.041	0.64
R-19 Interior w/tb	0.042	0.57
R-10 Exterior	0.064	0.57
R-12 Exterior	0.057	0.57
7-Feet Depth Below Grade		
Uninsulated	0.193	0.46
R-11 Interior	0.054	0.56
R-11 Interior w/tb	0.056	0.42
R-19 Interior	0.037	0.57
R-19 Interior w/b	0.038	0.43
R-10 Exterior	0.056	0.42
R-12 Exterior	0.050	0.42

SECTION 1003 - ON-GRADE SLAB FLOORS

1003.1 General: Table No. 10-2 lists heat-loss coefficients for heated on-grade slab floors, in units of BTU/°F-hr per lineal foot of perimeter.

1003.2 Component description: All on-grade slab floors are assumed to be 6-inch concrete poured directly onto the earth. The bottom of the slab is assumed to be at grade line. Monolithic and floating slabs are not differentiated.

Soil is assumed to have a conductivity of 0.75 Btu/h·°F·ft^2. Slabs 2 feet or more below grade should use basement coefficients.

1003.3 Insulation description: Coefficients are provided for the following three configurations:

a. **2-Foot (or 4-foot) vertical:** Insulation is applied directly to the slab exterior, extending downward from the top of the slab to a depth of 2-feet (or 4-feet) below grade.

b. **2-Foot (or 4-foot) horizontal:** Insulation is applied directly to the underside of the slab, and run horizontally from the perimeter inward for 2-feet or 4-feet. The slab edge is exposed in this configuration.

   Note: A horizontal installation with a thermal break of at least R-5 at the slab edge should use the vertical-case F-values.

c. **Fully insulated slab:** Insulation extends from the top of the slab, along the entire perimeter, and completely covers the area under the slab.

TABLE NO. 10-2 (Section 1003)
DEFAULT F-VALUES FOR ON-GRADE SLABS

Insulation type	R-0	R-5	R-10	R-15
Uninsulated slab	0.73	--	--	--
2-ft Horizontal (No thermal break)	--	0.70	0.70	0.69
4-ft Horizontal (No thermal break)	--	0.67	0.64	0.63
2-ft Vertical (or Horiz. w/T.B.)	--	0.58	0.54	0.52
4-ft Vertical (or Horiz. w/T.B.)	--	0.54	0.48	0.45
Fully insulated slab	--	--	0.36	--

SECTION 1004 - CRAWLSPACE FLOORS

1004.1 General: Table Nos. 10-3 and 10-4 list heat-loss coefficients for floors over crawlspaces in units of BTU/°F-hr per square foot of floor.

They are derived from procedures listed in Standard RS-1 listed in Chapter 7 assuming an average outdoor temperature of 45°F, an

average indoor temperature of 65°F, and a crawlspace area of 1350 ft^2 and 150 ft of perimeter. The crawlspace is assumed to be 2.5-feet high, with 24-inches below grade and 6-inches above grade.

1004.2 Crawlspace description: Four crawlspace configurations are considered: vented, unvented, enclosed, and heated plenum.

a. **Vented crawlspaces:** Assumed to have 3 air-changes per hour, with at least 1 ft^2 of net-free ventilation in the foundation for every 300 ft^2 of crawlspace floor area. The crawlspace is not actively heated. Floors over unheated areas, such as garages, may only use those values which have R-0 perimeter insulation.

b. **Unvented crawlspaces:** Assumed to have 1.5 air-changes per hour, with less than 1 ft^2 of net-free ventilation in the foundation for every 300 ft^2 of crawlspace floor area. The crawlspace is not actively heated. Floors over unheated basements may only use those values which have R-0 perimeter insulation.

c. **Heated-plenum crawlspaces:** Assumed to have 0.25 air-changes per hour, with no foundation vents. Heated supply air from central furnace is blown into a crawlspace and allowed to enter the living space unducted via holes cut into the floor.

d. **Enclosed floors:** Assumes no buffer space, and a covering of 1/2-inch T1-11 on the exterior of the cavity exposed to the outside air.

1004.3 Construction description: Floors are assumed to be either joisted floors framed on 16-inch centers, or post and beam on 4 by 8 foot squares. Insulation is assumed to be installed under the subflooring between the joists or beams with no space between the insulation and the subfloor. Insulation is assumed to be uncompressed.

Perimeter insulation is assumed to extend from the top of the rim joist to the crawlspace floor and then inward along the ground (on top of the ground cover) for at least 24 inches.

Floor coverings are assumed to be light carpet with rubber pad.

TABLE NO. 10-3 (Section 1004)
DEFAULT U-VALUES FOR FLOORS OVER VENTED CRAWLSPACE OR UNHEATED BASEMENT

Nominal R-value		U-Value	
Floor	Perimeter	Post & Beam	Joists
0	0	0.112	0.134
	11	0.100	0.116
	19	0.098	0.114
	30	0.093	0.107
11	0	0.052	0.056
	11	0.048	0.052
19	0	0.038	0.041
	11	0.036	0.038
22	0	0.034	0.037
	11	0.033	0.035
25	0	0.032	0.034
	11	0.031	0.033
30	0	0.028	0.029
	11	0.027	0.028
38	0	0.024	0.025
	11	0.024	0.024

TABLE NO. 10-4 (Section 1004)
DEFAULT U-VALUES FOR FLOORS OVER HEATED PLENUM CRAWLSPACES

Nominal R-value Perimeter	U-value
11	0.085
19	0.075
30	0.069

Note: Crawlspaces used as heated plenums have approximately 30-percent higher heat-loss rate than unvented crawlspaces with the same assumed ACH. Default U-values reflect this higher rate of heat loss.

SECTION 1005 - ABOVE-GRADE WALLS

1005.1 General: Table No. 10-5 lists heat-loss coefficients for the opaque portion of above-grade walls (BTU/°F-hr per square foot). They are derived from procedures listed in Standard RS-1 listed in Chapter 7 assuming exterior air films at 7.5-mph wind speed.

Insulation is assumed to uniformly fill the entire cavity and to be installed as per manufacturer's directions. All walls are assumed to be finished on the inside with 1/2-inch gypsum wallboard, and on the outside with either beveled wood siding over 1/2-inch plywood sheathing or with 5/8-inch T1-11 siding.

Insulated sheathing (either interior or exterior) is assumed to cover the entire opaque wall surface.

1005.2 Framing description: Three framing types are considered, and defined as follows:

a. **Standard:** Studs framed on 16-inch centers with double top plate and single bottom plate. Corners use 3 studs and each opening is framed using 2 studs. Headers consist of double 2X or single 4X material with an air space left between the header and the exterior sheathing. Interior partition wall/exterior wall intersections use 2 studs in the exterior wall.

Framing weighting factors:	Studs and plates	.19
	Insulated cavity	.77
	Headers	.04

b. **Intermediate:** Studs framed on 16-inch centers with double top plate and single bottom plate. Corners use 2 studs or other means of fully insulating corners, and each opening is framed by 2 studs. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

Framing weighting factors:	Studs and plates	.18
	Insulated cavity	.78
	Headers	.04

c. **Advanced:** Studs framed on 24-inch centers with double top plate and single bottom plate. Corners use 2 studs or other means of fully insulating corners, and 1 stud is used to support each header. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

Framing weighting factors:	Studs and plates	.13
	Insulated cavity	.83
	Headers	.04

1005.3 Component description: Default coefficients for one type of metal-stud wall and for three types of wood-stud walls are listed: single-stud walls, strap walls, and double-stud walls.

a. **Single-stud wall:** Assumes either 2x4 or 2x6 studs framed on 16 or 24-inch centers. Headers are solid for 2x4 walls and double 2x for 2x6 walls, with either dead-air or rigid-board insulation in the remaining space.

b. **Strap wall:** Assumes 2x6 studs framed on 16- or 24-inch centers. 2x3 or 2x4 strapping is run horizontally along the interior surface of the wall to provide additional space for insulation.

c. **Double-stud wall:** Assumes an exterior structural wall and a separate interior, non-structural wall. Insulation is placed in both wall cavities and in the space between the two walls. Stud spacing is assumed to be on 24-inch centers for both walls.

Default coefficients are also listed for masonry walls assuming 8 inch block 115 lb. density with minimum reinforcing and grout. This wall is then shown with four types of insulation: integral, cavity wall, exterior and interior. For the calculations expanded polystyrene is assumed to have an R-value of 3.8 per inch, extruded polystyrene 5.0 per inch and polyisocyanurate 7.2 per inch.

TABLE NO. 10-5 (Section 1005)
DEFAULT U-VALUES FOR ABOVE-GRADE WALLS

Single Metal Stud

Nominal Wall Thickness	Nominal Insulation R-Value	Effective Insulation R-Value	Stud Spacing 16" O.C.	Stud Spacing 24" O.C.
4 inch	R-11	R-11	.14	.13
4 inch	R-13	R-12.7	.13	.12
6 inch	R-19	R-18	.11	.10

Pre-Engineered Metal Buildings

Uncompressed Insulation R-Value	Overall Assembly U-Value
R-6	0.17
R-10	0.15
R-13	0.11

2X4 Single Wood Stud: R-11 Batt

	Siding Material/Framing Type			
	Lapped Wood		T1-11	
R-value of Foam Board	STD	ADV	STD	ADV
0	.088	.084	.094	.090
1	.080	.077	.085	.082
2	.074	.071	.078	.075
3	.069	.066	.072	.070
4	.064	.062	.067	.065
5	.060	.058	.063	.061
6	.056	.055	.059	.057
7	.053	.052	.055	.054
8	.051	.049	.052	.051
9	.048	.047	.050	.049
10	.046	.045	.047	.046
11	.044	.043	.045	.044
12	.042	.041	.043	.042

NOTE:
Nominal Batt R-value: R-11 at 3.5-inch thickness

Installed Batt R-value: R-11 in 3.5-inch cavity

2x4 Single Wood Stud: R-13 Batt

R-Value of Foam Board	Siding Material/Framing Type: Lapped Wood STD	Lapped Wood ADV	T1-11 STD	T1-11 ADV
0	.082	.078	.088	.083
1	.075	.072	.080	.076
2	.069	.066	.073	.070
3	.065	.062	.068	.065
4	.060	.058	.063	.061
5	.057	.055	.059	.057
6	.053	.052	.056	.054
7	.051	.049	.052	.051
8	.048	.047	.050	.048
9	.046	.045	.047	.046
10	.044	.043	.045	.044
11	.042	.041	.043	.042
12	.040	.039	.041	.040

NOTE:
Nominal Batt R-value: R-13 at 3.63-inch thickness

Installed Batt R-value: R-12.7 at 3.5-inch cavity

2X4 Single Wood Stud: R-15 Batt

R-Value of Foam Board	Siding Material/Framing Type: Lapped Wood STD	Lapped Wood ADV	T1-11 STD	T1-11 ADV
0	.076	.071	.081	.075
1	.069	.065	.073	.069
2	.064	.061	.068	.069
3	.060	.057	.063	.059
4	.056	.053	.059	.056
5	.053	.051	.055	.052
6	.050	.048	.052	.050
7	.047	.046	.049	.047
8	.045	.044	.047	.045
9	.043	.042	.044	.043
10	.041	.040	.042	.041
11	.039	.038	.041	.039
12	.038	.037	.039	.038

Note:
Nominal Batt R-value: R-15 at 3.5-inch thickness

Installed Batt R-value: R-15 in 3.5-inch cavity

2 x 6 Single Wood Stud: R-19 Batt

	R-value of Foam Board	Siding Material/Framing Type: Lapped Wood STD	Lapped Wood INT	Lapped Wood ADV	T1-11 STD	T1-11 INT	T1-11 ADV
NOTE: Nominal Batt R-value R-19 at 6-inch thickness Installed Batt R-Value: R-18 in 5.5-inch cavity	0	.062	.058	.055	.065	.061	.058
	1	.058	.055	.052	.060	.057	.055
	2	.054	.052	.050	.056	.054	.051
	3	.051	.049	.047	.053	.051	.049
	4	.048	.046	.045	.050	.048	.046
	5	.046	.044	.043	.048	.046	.044
	6	.044	.042	.041	.045	.044	.042
	7	.042	.040	.039	.043	.042	.040
	8	.040	.039	.038	.041	.040	.039
	9	.038	.037	.035	.039	.038	.037
	10	.037	.036	.035	.038	.037	.036
	11	.036	.035	.034	.036	.035	.035
	12	.034	.033	.033	.035	.034	.033

2x6 Single Wood Stud: R-21 High Density Batt System

	R-value of Foam Board	Siding Material/Framing Type: Lapped Wood STD	Lapped Wood INT	Lapped Wood ADV	T1-11 STD	T1-11 INT	T1-11 ADV
NOTE: Nominal Batt R-value: R-21 at 5.5-inch thickness Installed Batt R-value: R-21 in 5.5 inch cavity	0	.057	.054	.051	.060	.056	.053
	1	.054	.051	.048	.056	.053	.050
	2	.050	.048	.045	.052	.050	.047
	3	.048	.045	.043	.049	.047	.045
	4	.045	.043	.041	.047	.045	.043
	5	.043	.041	.040	.044	.042	.041
	6	.041	.039	.038	.042	.041	.039
	7	.039	.038	.036	.040	.039	.037
	8	.038	.036	.035	.039	.037	.036
	9	.036	.035	.034	.037	.036	.035
	10	.035	.034	.033	.036	.035	.033
	11	.033	.033	.032	.034	.033	.032
	12	.032	.031	.031	.033	.032	.031

2 x 6 Single Wood Stud: R-22 Batt

		Siding Material/Framing Type					
	R-value of Foam Board	Lapped Wood			T1-11		
		STD	INT	ADV	STD	INT	ADV
NOTE:							
Nominal Batt R-value:	0	.059	.055	.052	.062	.058	.054
R-22 at 6.75-inch thickness							
	1	.055	.052	.049	.057	.054	.051
Installed Batt R-value	2	.052	.049	.047	.054	.051	.048
R-20 in 5.5-inch cavity	3	.049	.046	.044	.050	.048	.046
	4	.046	.044	.042	.048	.046	.044
	5	.044	.042	.041	.045	.043	.042
	6	.042	.040	.039	.043	.042	.040
	7	.040	.039	.037	.041	.040	.038
	8	.038	.037	.036	.039	.038	.037
	9	.037	.036	.035	.038	.037	.035
	10	.035	.034	.033	.036	.035	.034
	11	.034	.033	.032	.035	.034	.033
	12	.033	.032	.031	.034	.033	.032

2 x 6 Single Wood Stud: 2 R-11 Batts

		Siding Material/Framing Type					
	R-Value of Foam Board	Lapped Wood			T1-11		
		STD	INT	ADV	STD	INT	ADV
NOTE:							
Nominal Batt R-value:	0	.060	.057	.054	.063	.059	.056
R-13 at 3.63-inch thickness							
	1	.056	.053	.051	.059	.056	.053
Installed Batt R-value:	2	.053	.050	.048	.055	.052	.050
R-12.7 in 3.5-inch cavity	3	.050	.048	.046	.052	.049	.047
	4	.047	.045	.044	.049	.047	.045
	5	.045	.043	.042	.046	.045	.043
	6	.043	.041	.040	.044	.043	.041
	7	.041	.040	.038	.042	.041	.039
	8	.039	.038	.037	.040	.039	.038
	9	.038	.037	.036	.039	.038	.036
	10	.036	.035	.034	.037	.036	.035
	11	.035	.034	.033	.036	.035	.034
	12	.034	.033	.032	.034	.034	.033

2 x 8 Single Wood Stud: R-25 Batt

		Siding Material/Framing Type					
	R-value of Foam Board	Lapped Wood			T1-11		
		STD	INT	ADV	STD	INT	ADV
NOTE:	0	.051	.047	.045	.053	.049	.046
Nominal Batt R-value:							
R-25 at 8-inch thickness	1	.048	.045	.043	.049	.046	.044
	2	.045	.043	.041	.047	.044	.042
Installed Batt R-value:	3	.043	.041	.039	.044	.042	.040
R-23.6 in 7.25-inch cavity	4	.041	.039	.037	.042	.040	.038
	5	.039	.037	.036	.040	.038	.037
	6	.037	.036	.035	.038	.037	.036
	7	.036	.035	.033	.037	.035	.034
	8	.036	.033	.032	.035	.034	.033
	9	.033	.032	.031	.034	.033	.032
	10	.032	.031	.030	.033	.032	.031
	11	.031	.030	.029	.032	.031	.030
	12	.030	.029	.028	.031	.030	.029

2 x 6: Strap Wood Wall

	Siding Material/Frame Type			
	Lapped Wood		T1-11	
	STD	ADV	STD	ADV
R-19 + R-11 Batts	.036	.035	.038	.036
R-19 + R-8 Batts	.041	.039	.042	.040

2 x 6 + 2 x 4: Double Wood Stud

			Siding Material/Framing Type			
Batt Configuration			Lapped Wood		T1-11	
Exterior	Middle	Interior	STD	ADV	STD	ADV
R-19	------	R-11	.040	.037	.041	.038
R-19	------	R-19	.034	.031	.035	.032
R-19	R-8	R-11	.029	.028	.031	.029
R-19	R-11	R-11	.027	.026	.028	.027
R-19	R-11	R-19	.024	.023	.025	.023
R-19	R-19	R-19	.021	.020	.021	.020

2 x 4 + 2 x 4 : Double Wood Stud

Batt Configuration			Siding Material/Framing Type			
			Lapped Wood		T1-11	
Exterior	Middle	Interior	STD	ADV	STD	ADV
R-11	------	R-11	.050	.046	.052	.048
R-19	------	R-11	.039	.037	.043	.039
R-11	R-8	R-11	.037	.035	.036	.036
R-11	R-11	R-11	.032	.031	.033	.032
R-13	R-13	R-13	.029	.028	.029	.028
R-11	R-19	R-11	.026	.026	.027	.026

Log Wall

NOTE:
R-value of wood:
R-1.25 per inch thickness

Average wall thickness
90% average log diameter

Average Log Diameter	U-value
6-inch	0.148
8-inch	0.111
10-inch	0.089
12-inch	0.074
14-inch	0.063
16-inch	0.056

Stress Skin Panel

NOTE:
R-value of expanded polystyrene: R-3.85/inch
Framing: 6%
Spline: 8%
No thermal bridging between interior and exterior splines.

Panel Thickness	U-value
3 1/2-inch	.071
5 1/2-inch	.054
7 1/4-inch	.037
9 1/4-inch	.030
11 1/4-inch	.025

Masonry Walls

Integral Insulation Cases:

Core Insulation	Core Conductivity	U-Value
Base Wall uninsulated	0.449	0.558
Vermiculite K=.44	0.037	0.479
Perlite K = .34	0.028	0.477
Korfil 1 lb.		0.49

Cavity Wall Insulation	Insulation R-value	U-Value
1" expanded Polystyrene	3.8	0.179
1" extruded Polystyrene	5.0	0.147
1½" expanded Polystyrene	5.7	0.133
1½" extruded Polystyrene	7.5	0.108
2" expanded Polystyrene	7.6	0.106
2" extruded Polystyrene	10.0	0.085
2" Polyisocyanurate	14.4	0.062
2.5" Polyisocyanurate	18.0	0.051
3" Polyisocyanurate	21.6	0.043
3.5" Polyisocyanurate	25.2	0.037

Exterior Insulation Cases:

Wall Insulation	Insulation R-value	U-Value
3/4" Insulating Stucco	1.0	0.358
1" expanded Polystyrene	3.8	0.179
1" extruded Polystyrene	5.0	0.147
2" expanded Polystyrene	7.6	0.106
2" extruded Polystyrene	10.0	0.085
2" Polyisocyanurate	14.4	0.062
2.5" Polyisocyanurate	18.0	0.051
3" Polyisocyanurate	21.6	0.043
3.5" Polyisocyanurate	25.2	0.037

Interior Insulation:

Note: 1.5" furring at 16" OC = 12.5% of area
Added R-value Calculated using Isothermal Planes Method

Insulation Section		Furring Section		Insulation Layer		Wall U-Value
R-Val	U-Val	Thick	U-Val	U-Val	R-Val	Total
2.181	0.458	0.750	1.067	0.534	1.871	0.273
4.684	0.213	0.750	1.067	0.320	3.124	0.203
7.600	0.132	2.000	0.400	0.165	6.056	0.127
10.000	0.100	2.000	0.400	0.138	7.273	0.110
14.400	0.069	2.000	0.400	0.111	9.028	0.092
18.000	0.056	2.500	0.320	0.089	11.285	0.076
21.600	0.046	3.000	0.267	0.074	13.542	0.065
25.200	0.040	3.500	0.229	0.063	15.799	0.057

SECTION 1006 - DEFAULT U-VALUES FOR GLAZING AND DOORS

1006.1 Untested Glazing and Doors: Untested glazing and doors shallbe assigned the following U-values:

a. Manufactured glazing products:

single glazing (all): U = 1.20;
double glazing:
aluminum or steel framed: U = 0.90;
wood or vinyl framed: U = 0.75;

b. Non-manufactured site built fixed lite glazing products with a minimum of one-half inch airspace in a wood frame only. (All products supplied by manufacturers, such as kits for solariums, shall use the default U-values for manufactured glazing products cited above.)

air-filled:	U = 0.60;
argon-filled:	U = 0.55;
low-e, air-filled:	U = 0.50;
low-e, argon-filled	U = 0.40;

Products which do not comply with all of these criteria shall use the default U-values listed under manufactured glazing products.

c. For doors, see Table No. 10-6 on the next page.

TABLE NO. 10-6 (Section 1006)
TRANSMISSION COEFFICIENTS (U) FOR WOOD AND STEEL DOORS
Btu/h·ft^2·°F

Nominal Door Thickness, Inches	Description	No Storm Door	Wood Storm Door[c]	Metal Storm Door[d]
Wood Doors[a,b]				
1-3/8	Panel door with 7/16-in panels[e]	0.57	0.33	0.37
1-3/8	Hollow core flush door	0.47	0.30	0.32
1-3/8	Solid core flush door	0.39	0.26	0.28
1-3/4	Panel door with 7/16-in panels[e]	0.57	0.33	0.36
1-3/4	Hollow core flush door	0.46	0.29	0.32
1-3/4	Panel door with 1-1/8-in panels[e]	0.39	0.26	0.28
1-3/4	Solid core flush door	0.33	0.28	0.25
2-1/4	Solid core flush door	0.27	0.20	0.21
Steel Doors[b]				
1-3/4	Fiberglass or mineral wool core with steel stiffeners, no thermal break[f]	0.60	-----	-----
1-3/4	Paper honeycomb core without thermal break[f]	0.56	-----	-----
1-3/4	Solid urethane foam core without thermal break[a]	0.40	-----	-----
1-3/4	Solid fire rated mineral fiberboard core without thermal break[f]	0.38	-----	-----
1-3/4	Polystyrene core without thermal break (18 gage commercial steel)[f]	0.35	-----	-----
1-3/4	Polyurethane core without thermal break (18 gage commercial steel)[f]	0.29	-----	-----
1-3/4	Polyurethane core without thermal break (24 gage commercial steel)[f]	0.29	-----	-----

1-3/4	Polyurethane core with thermal break and wood perimeter (24 gauge commercial steel)[f]	0.20	-----	-----
1-3/4	Solid urethane foam core with thermal break[a]	0.19	0.16	0.17

Note: All U-factors for exterior doors in this table are for doors with no glazing, except for the storm doors which are in addition to the main exterior door. Any glazing area in exterior doors should be included with the appropriate glass type and analyzed. Interpolation and moderate extrapolation are permitted for door thicknesses other than those specified.

[a] Values are based on a nominal 32 by 80 in. door size with no glazing.

[b] Outside air conditions: 15 mph wind speed, 0°F air temperature; inside air conditions: natural convection, 70°F air temperature.

[c] Values for wood storm door are for approximately 50 percent glass area

[d] Values for metal storm door are for any percent glass area.

[e] 55 percent panel area.

[f] ASTM C 236 hotbox data on a nominal 3 by 7 ft door size with no glazing.

The U-factors in Table No. 10-6 are for exterior wood and steel doors. The values given for wood doors were calculated, and those for steel doors were taken from hot box tests (Sabine et al. 1975: Yellot 1965) or from manufacturer's test reports. An outdoor surface conductance of 6.0 Btu/h·ft^2·°F was used, and the indoor surface conductance was taken as 1.4 Btu/h·ft^2·°F for vertical surfaces with horizontal heat flow. All values given are for exterior doors without glazing. If an exterior door contains glazing, the glazing should be analyzed as a window.

SECTION 1007 - CEILINGS

1007.1 General: Table No. 10-7 lists heat-loss coefficients for the opaque portion of exterior ceilings below vented attics, vaulted ceilings, and roof decks in units of Btu/°F·hr per square foot of ceiling.

They are derived from procedures listed in Standard RS-1 listed in Chapter 7. Ceiling U-values are modified for the buffering effect of the attic, assuming an indoor temperature of 65°F and an outdoor temperature of 45°F.

1007.2 Component description: The three types of ceilings are characterized as follows:

a. **Ceilings below a vented attic:** Attic insulation is assumed to be blown-in, loose-fill fiberglass with a K-value of 2.6 hr·°F·ft^2/Btu per inch. Full bag count for specified R-value is assumed in all cases. Ceiling dimensions for flat ceiling calculations are 45 x 30 feet, with a gabled roof having a 4/12 pitch. The attic is assumed

to vent naturally at the rate of 3 ACH through soffit and ridge vents. A void fraction of 0.002 is assumed for all attics with insulation baffles. Standard-framed, unbaffled attics assume a void fraction of 0.008.

Attic framing is either standard or advanced. Standard framing assumes tapering of insulation depth around the perimeter with resultant decrease in thermal resistance. An increased R-value is assumed in the center of the ceiling due to the effect of piling leftover insulation. Advanced framing assumes full and even depth of insulation extending to the outside edge of exterior walls. Advanced framing does not change from the default value.

U-values for flat ceilings below vented attics with standard framing may be modified with the following table:

	U-Value for Standard Framing	
Roof Pitch	**R-30**	**R-38**
4/12	.036	.031
5/12	.035	.030
6/12	.034	.029
7/12	.034	.029
8/12	.034	.028
9/12	.034	.028
10/12	.033	.028
11/12	.033	.027
12/12	.033	.027

Vented scissors truss attics assume a ceiling pitch of 2/12 with a roof pitch of either 4/12 or 5/12. Unbaffled standard framed scissors truss attics are assumed to have a void fraction of .016.

b. **Vaulted ceilings:** Insulation is assumed to be fiberglass batts installed in roof joist cavities. In the vented case, at least 1.5-inches between the top of the batts and the underside of the roof sheathing is left open for ventilation in each cavity. A ventilation rate of 3 ACH is assumed. In the unvented or dense pack case, the ceiling cavity is assumed to be fully packed with insulation, leaving no space for ventilation.

c. **Roof decks:** Rigid insulation is applied to the top of roof decking with no space left for ventilation. Roofing materials are attached directly on top of the insulation. Framing members are often left exposed on the interior side.

TABLE NO. 10-7 (Section 1007)
DEFAULT U-VALUES FOR CEILINGS

Wood Frame Ceilings Below Vented Attics

	Standard Frame	Advanced Frame
Flat Ceiling	**Baffled**	
R-19	0.049	0.047
R-30	0.036	0.032
R-38	0.031	0.026
R-49	0.027	0.020
R-60	0.025	0.017
Scissors Truss		
R-30 (4/12 roof pitch)	0.043	0.031
R-38 (4/12 roof pitch)	0.040	0.025
R-49 (4/12 roof pitch)	0.038	0.020
R-30 (5/12 roof pitch)	0.039	0.032
R-38 (5/12 roof pitch)	0.035	0.026
R-49 (5/12 roof pitch)	0.032	0.020

Wood Frame Vaulted Ceilings

	16" O.C.	24" O.C.
Vented		
R-19 2x10 joist	0.049	0.048
R-30 2x12 joist	0.034	0.033
R-38 2x14 joist	0.027	0.027
Unvented		
R-30 2x10 joist	0.034	0.033
R-38 2x12 joist	0.029	0.027
R-21 + R-21 2x12 joist	0.026	0.025

Wood Frame Roof Deck

		4x Beams, 48" O.C.
R-12.5	2" Rigid insulation	0.064
R-21.9	3.5" Rigid insulation	0.040
R-37.5	6" Rigid insulation	0.025
R-50	8" Rigid insulation	0.019

Pre-Engineered Metal Buildings
NOTE: Based on 5 foot purlins spacing

Uncompressed Insulation R-Value	Standard Installation - Insulation Laid Over Purlins and Compressed	Insulation Laid Out Parallel to and between Purlins and Not Compressed, Plus R-Thermal Block Separating Purlins from Roof Deck
R-6	0.20	0.12
R-10	0.14	0.09
R-13	0.12	0.08
R-19	0.09	0.07

SECTION 1008 - AIR INFILTRATION

1008.1 General: Table Nos. 10-8 and 10-9 list effective air-change rates and heat capacities for heat loss due to infiltration.

Estimated seasonal average infiltration rates in air changes per hour (ACH) are given for the two levels of air-leakage control (see Section 4.6 of the Technical Specifications). The energy-effective air-change rate shall be used in calculations for compliance under Thermal Performance or Energy Budgets.

Heat loss due to infiltration shall be computed using the following equation:

$$Q_{infil} = ACH_{eff} * HCP$$

Where: Q_{infil} = Heat loss due to air infiltration

ACH_{eff} = the effective infiltration rate as given in Table No. 10-8

HCP = the Heat Capacity Density Product for the appropriate elevation or climate zone as given below.

TABLE NO. 10-8 (Section 1008)
ASSUMED EFFECTIVE AIR-CHANGES PER HOUR

Air-Leakage Control Package	Air-Changes per Hour Natural	Effective
Standard	0.35	0.35

TABLE NO. 10-9 (Section 1008)
DEFAULT HEAT CAPACITY/DENSITY PRODUCT FOR AIR

Average Elevation	Heat Capacity/Density	
Mean Sea Level	0.0180	Btu/Hr· °F

SECTION 1009 - MASS

1009.1 General: Table No. 10-10 lists default mass-values for residential construction types. All calculations are based on standard ASHRAE values for heat-storage capacity as listed in 1989 Handbook of Fundamentals, Chapter 22.

Thermal capacity of furniture is ignored, as is heat storage beyond the first 4 inches of mass thickness. All mass is assumed to be in direct contact with the conditioned space. Concrete separated from the heated volume by other materials must multiply the listed concrete mass value by the result of the following formula:

$$Ln(R\text{-value}) \times (-.221) + 0.5$$

Where:

Ln = Natural log
R-value = R-value of material covering concrete

Note: All default values for covered concrete slabs have been adjusted according to this procedure.

1009.2 Mass description: Mass is divided into two types: structural, and additional.

a. **Structural mass:** Includes heat-storage capacity of all standard building components of a typical residential structure, including floors, ceilings, and interior and exterior walls in Btu/°F·ft^2 of floor area. It also assumes exterior wall, interior wall, and ceiling surface area approximately equals three times the floor area.

b. **Additional mass:** Includes any additional building material not part of the normal structure, which is added specifically to increase the building's thermal-storage capability. This category includes masonry fireplaces, water or Trombe walls, and extra layers of sheetrock. Coefficients are in Btu/°F·ft^2 of surface area of material exposed to conditioned space. The coefficient for water is Btu/°F·Gallon.

1009.3 Component description: Light frame assumes 1-inch thick wood flooring with 5/8-inch sheetrock on ceilings and interior walls, and walls consisting of either 5/8-inch sheetrock or solid logs. Slab assumes a 4-inch concrete slab on or below grade, with 5/8-inch sheetrock on exterior and interior walls and ceiling, and with separate values for interior or exterior wall insulation. Adjustments for slab covering is based on R-value of material. Additional mass values are based on the density multiplied by the specific heat of the material adjusted for listed thickness.

TABLE NO. 10-10 (Section 1009)
DEFAULT MASS VALUES

Structural Mass M-Value	**Btu/°F-Ft^2 floor area**
Light frame:	
Joisted/post and beam floor, sheetrock walls and ceilings	3.0
Joisted/post and beam floor, log walls, sheetrock ceilings	4.0
Slab with interior wall insulation:	
Slab, no covering or tile, sheetrock walls and ceilings	10.0
Slab, hardwood floor covering, sheetrock walls and ceilings	7.0
Slab, carpet and pad, sheetrock walls and ceilings	5.0
Slab with exterior wall insulation:	
Slab, no covering or tile, sheetrock walls and ceilings	12.0
Slab, hardwood floor covering, sheetrock walls and ceilings	9.0
Slab, carpet and pad, sheetrock walls and ceilings	7.0
Additional Mass M-Value	**Btu/°F-FT^2 surface area**
Gypsum wallboard, 1/2-inch thickness	0.54
Gypsum wallboard, 5/8-inch thickness	0.68
Hardwood floor	1.40
Concrete/Brick, 4 inch-thickness	10.30
Concrete/Brick, 6 inch-thickness	15.40
	Btu/°F-gallon
Water, 1 gallon	8.0

Section 28: As of July 1, 1991, the Appendix of the 1989 Model Energy Code is hereby repealed.

Section 29: As of July 1, 1991, Section 403 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding definitions as follows:

Sec. 403.

* * *

AIR, TRANSFER is the movement of indoor air from one space to another.

AIR, VENTILATION is that portion of supply air that is outdoor air plus any recirculated air that has been treated for the purpose of maintaining acceptable indoor air quality.

* * *

AMCA is Air Movement and Control Association, Inc.

* * *

ASHRAE is American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.

* * *

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

Section 30: As of July 1, 1991, Section 404 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding definitions as follows:

Sec. 404. **BACK-DRAFT DAMPER** is a damper installed to restrict introduction of unconditioned air from an unconditioned space to a conditioned space.

BAROMETRIC DAMPER is any listed non-manual device that freely allows the flow of air in one direction, but does not allow conditioned air to escape. Any installed combustion air damper shall meet the installation requirements of the manufacturer.

* * *

Section 31: As of July 1, 1991, Section 405 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding the following definition:

Sec. 405.

* * *

CFM is cubic feet per minute.

* * *

Section 32: As of July 1, 1991, Section 406 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding the following definition:

Sec. 406.

* * *

DEHUMIDISTAT is an automatic control device which measures changes in humidity and controls a device(s) for maintaining a maximum specified humidity range or level.

* * *

Section 33: As of July 1, 1991, Section 408 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended as follows:

Sec. 408.

* * *

FIREPLACE ((~~is an open fire chamber with a hearth, or similarly prepared recess for containing a fire at the base of a chimney. Factory-built Fireplace is a fireplace composed of listed factory-built components assembled in accordance with the terms of listing to form the completed fireplace. Masonry Fireplace is a hearth and fire chamber of solid masonry units such as bricks, stones, listed masonry units, or reinforced concrete, provided with a suitable chimney, constructed in accordance with applicable code requirements.~~)) See **SOLID FUEL BURNING APPLIANCE.**

* * *

Section 34: As of July 1, 1991, Section 410 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding definitions as follows:

Sec. 410. HABITABLE SPACE (ROOM). Space in a structure for living sleeping, eating or cooking. Bathrooms, toilet compartments, closets, halls storage or utility space and similar areas, are not considered habitable space. For the purpose of this Code, a single habitable space may consist of adjoining rooms when one half of the area of the common wall is open and

unobstructed and provides an opening of not less than one-tenth of the floor area of the interior room or twenty five square feet, whichever is greater.

* * *

HEAT RECOVERY VENTILATION SYSTEM is a device or combination of devices applied to provide the outdoor air for ventilation in which energy is transferred between the intake and exhaust airstream.

* * *

HVAC is heating, ventilating and air conditioning.

HVI is Home Ventilating Institute of America, Inc.

Section 35: As of July 1, 1991, Section 415 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding the following definition:

Sec. 415.

* * *

MANUAL. Capable of being operated by human intervention.

* * *

Section 36: As of July 1, 1991, Section 417 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding the following definition:

Sec. 417.

* * *

OCCUPIED ZONE is the region within an occupied space between planes 3 and 72 inches (75 and 1800 mm) above the floor and more than 2 feet (600 mm) from the walls of fixed air-conditioning equipment (see ASHRAE Standard 55-1981, Ref. 1).

Section 37: As of July 1, 1991, Section 420 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding the following definition:

Sec. 420. R VALUE. (See **THERMAL RESISTANCE (R)**).

* * *

Section 38: As of July 1, 1991, Section 421 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended as follows:

Sec. 421.

* * *

((~~SOLID FUEL. Fuels in solid form, limited to natural wood and coal. Charcoal, artificial logs and other manufactured products are not included.~~))

SOLID FUEL BURNING APPLIANCE is any factory-built or site built appliance designed to provide heat for a structure by burning solid fuels.

SOURCE SPECIFIC VENTILATION SYSTEM is a mechanical ventilation system including all fans, controls and ducting, which is dedicated to exhausting contaminant-laden air to the exterior of the building from the room or space in which the contaminant is generated.

* * *

SYSTEM is a combination of equipment and/or controls, accessories, interconnecting means, and terminal elements by which air is transferred.

Section 39: As of July 1, 1991, Section 422 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding definitions as follows:

Sec. 422. TERMINAL ELEMENT is the means by which the transferred air from a system is finally delivered; i.e., registers diffusers, through-the-wall vents, roofs caps, etc.

THERMAL RESISTANCE (R) is the resistance fo a material to heat flow, measured as the inverse of heat flow per unit area, per unit time, per unit temperature difference across the thickness of material considered. In this Code, R has units of sq.ft./hr./°F/Btu.

* * *

Section 40: As of July 1, 1991, Section 423 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding the following definition:

Sec. 423.

* * *

UNCONDITIONED SPACE. (See CONDITIONED SPACE).

* * *

Section 41: As of July 1, 1991, Section 424 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding definitions as follows:

Sec. 424.

* * *

VENTILATION is the process of supplying and removing air by natural or mechanical means to and from any space. Such air may or may not be conditioned.

VENTILATION EFFECTIVENESS is the fraction of the outdoor air delivered to the space that reaches the occupied zone.

VENTILATION, MECHANICAL is the introduciton and distribution of outdoor air and the removal of indoor air by mechanical means.

VENTILATION, NATURAL is ventilation other than by mechanical means.

* * *

Section 42: As of July 1, 1991, Section 425 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended by adding definitions as follows:

Sec. 425.

* * *

WHOLE HOUSE VENTILATION SYSTEM is a mechanical ventilation system, including fans, controls, and ducts, which replaces, by direct or indirect means, air from the habitable rooms with outdoor air.

WOOD STOVE. (See SOLID FUEL BURNING APPLIANCE).

* * *

Section 43: As of July 1, 1991 Section 426 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is by adding the following definition:

Sec. 426. Zone is a space or group of spaces within a building with heating and/or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

Section 44: As of July 1, 1991, Section 601 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended as follows:

Sec. 601. (a) **Air Supply.** Fuel-burning equipment shall be assured a sufficient supply of combustion air. The methods of providing combustion air in this chapter do not apply to direct vent appliances, appliances listed as having separated combustion systems, enclosed furnaces, listed cooking appliances, refrigerators and domestic clothes dryers. ((~~Fireplace combustion air supply shall be ducted directly from the outside of the building. Material and size of combustion air duct for a fireplace shall comply with Section 604(a) and Section 502.4.6 of the Seattle Energy Code.~~)) Fireplaces and solid fuel burning appliances shall comply with Chapter 10.1 Combustion air shall be obtained from outside.

EXCEPTION: For other than fireplaces and solid fuel burning appliances, where existing equipment is being replaced with other equipment of equal or smaller size, all or a portion of the combustion air for fuel-burning appliances may be obtained from infiltration when the requirement for 50 cubic feet per 1000 Btu/h input is met.

(b) ((~~Volume. 1. Adequate volume. If the volume of the room or space in which fuel-burning appliances are installed is equal to or greater than 50 cubic feet per 1000 Btu/h of aggregate input rating of appliances, infiltration may be regarded as adequate to provide combustion air. Exclude from the calculation the input ratings of listed direct vent appliances, enclosed furnaces, cooking appliances, refrigerators and domestic clothes dryers.~~

~~2. Insufficient volume--solid fuel. Rooms or spaces containing solid fuel-burning appliances which do not have the volume specified in Subsection (b) 1 above shall be provided~~

~~with unobstructed openings equal to 2 square inches for each 1000 Btu/h combined input rating with a minimum total free area of 200 square inches arranges as specified in Sections 602 and 603 of this code.~~

~~3. Insufficient volume--gas and liquid. Rooms or spaces containing gas- or liquid-fuel-burning appliances which do not have the volume as specified in Subsection (b) 1 above shall be provided with minimum obstructed combustion air openings as specified in Section 607 and arranged as specified in Sections 602 and 603 of this code.~~

~~4.~~)) **Existing buildings.** When fuel-burning appliances are installed in an existing building containing other fuel-burning equipment, the room or space shall be provided with sufficient combustion air for all fuel-burning equipment contained therein.

Section 45: As of July 1, 1991, Section 602 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended as follows:

Sec. 602. (a) **Location.** Approximately one half of the required combustion air opening area shall be located within the upper 12 inches of the enclosure and approximately one half of the opening area shall be located within the lower 12 inches of the enclosure.

EXCEPTION: Where an existing furnace is being replaced with another furnace of equal or smaller size and the room is not being remodeled, one opening location may be provided.

(b) **Dampers prohibited.** Combustion air openings shall not be installed so as to pass through construction where fire dampers are required. Volume dampers shall not be installed in combustion air openings.

EXCEPTION: Fireplaces and solid fuel burning appliances shall comply with Chapter 10.1

(c) **Screening.** Combustion air openings shall be covered with corrosion-resistant screen of 1/4-inch mesh, except as provided in Section 604(c).

Section 46: As of July 1, 1991, Section 604 of the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 is amended as follows:

Sec. 604 (a) **General.** Combustion air ducts shall:

1. Be of galvanized steel complying with Chapter 10 or equivalent corrosion-resistant material approved for this use:

EXCEPTION: In Group R, Division 3 Occupancies, unobstructed stud and joist spaces may be used, provided not more than one required fire stop is removed.

2. Have a minimum cross-sectional dimension of 3 inches.

3. Terminate in a space at least 3 inches in depth open to the front or firebox side of the appliance. Such space shall extend from the floor to the ceiling of the appliance enclosure.

4. Have the same cross-sectional areas as the free area of the openings to which they connect.

5. Serve a single appliance enclosure.

6. Serve only upper or lower combustion air openings; the separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air.

(b) **Dampers.** Combustion air ducts shall not be installed so as to pass through construction where fire dampers are required. Volume dampers shall not be installed in combustion air ducts((~~, provided that volume dampers shall be installed in the combustion air ducts for all fireplaces~~)).

EXCEPTION: Fireplaces and solid fuel burning appliances shall comply with Chapter 10.1.

c) **Screen.** Neither end of ducts which terminate in an attic shall be screened.

Section 47: As of July 1, 1991, the Seattle Mechanical Code as adopted by Ordinances 113702 and 113703 amended by adding a new Chapter 10.1 and Table Nos. 10.1-A, 10.1-B, 10.1-C and 10.1-D as follows:

CHAPTER 10.1
VENTILATION AND INDOOR AIR QUALITY

SCOPE AND GENERAL REQUIREMENTS

Sec. 10.101 (a) **Purpose.** The purpose of this chapter is to provide minimum standards for the design and installation of mechanical ventilation systems and the selection of structural materials used within the conditioned space for new construction.

It is intended that these provisions provide flexibility to permit the use of innovative approaches and techniques. These provisions are structured to permit compliance with the intent of this chapter by demonstration of performance through on-site testing or through engineered design. This chapter is not intended to abridge any safety or health requirements required under any other applicable codes or ordinances.

(b) **Scope.** This chapter sets forth minimum requirements for ventilation in all occupancies, including the design of new construction.

APPLICATION TO EXISTING BUILDINGS

Sec. 10.102 (a) **Additions to Existing Buildings.** Additions to existing buildings or structures may be made without making the entire building comply, provided that the new addition shall conform to the provisions of this chapter.

> **EXCEPTION:** Additions that do not include kitchens, bathrooms, water closets, indoor swimming pools, spas and other areas where excess water vapors are produced and are less than 500 square feet are exempt from Sections 10.103 and 10.104.

(b) **Alterations and Repairs.** All substantial alterations and repairs may be made to existing buildings or moved buildings built or permitted prior to the enforcement of this Chapter without making the entire building comply with the provisions of this Chapter, provided the alterations or repairs comply with this Chapter.

(c) **Historic Buildings.** Buildings which are designated as historical landmarks are exempt from this Chapter only to the extent necessary to preserve those features essential to their historical appearance or function.

MINIMUM VENTILATION CRITERIA FOR ALL GROUP R OCCUPANCIES

Sec. 10.103 (a). This section shall apply to all Group R occupancies as defined by the Building Code. Compliance with this section shall be demonstrated through engineering calculations or performance testing. Documentation of calculations shall be submitted to the building official where required. Performance testing shall be conducted in accordance with recognized test methods.

(b) **Minimum Ventilation Performance.** Each dwelling unit or guest room shall be equipped with source specific and whole house ventilation systems designed and installed to satisfy the ventilation requirements of this chapter.

> **EXCEPTION:** All public corridors shall meet the ventilation requirements in Section 1205 of the Building Code.

(c) **Source Specific Ventilation.** Source specific exhaust ventilation shall be required in each kitchen, bathroom, water closet, laundry facility, indoor swimming pool, spa, and other rooms where excess water vapor or cooking odor is produced.

The minimum source specific ventilation effective exhaust capacity shall be not less than levels specified in Table No. 10.1-A.

(d) **Whole House Ventilation Systems.** Each dwelling unit shall be equipped with a whole house ventilation system which shall be capable of providing at least 0.35 air changes per hour, but not less than 15 cubic feet per minute per bedroom plus an additional 15 cubic feet per minute. Whole house ventilation systems shall be designed to limit ventilation to a level no greater than 0.5 air changes per hour under normal operation conditions. Whole house ventilation systems shall supply outside air to all habitable rooms through individual outside air inlets, forced-air heating system, ducting or equivalent means. Doors and operable lites in windows are deemed not to meet the outside air supply intake requirements.

(e) **Controls.** All ventilation system controls shall be readily accessible. Controls for whole house ventilation systems shall be capable of operating the ventilation system without energizing other energy-consuming appliances.

EXCEPTION: Continuously operated whole house ventilation systems switch shall not be readily accessible by the occupant.

A. **Source Specific Ventilation Systems.** Source specific ventilation systems shall be controlled by manual switches, dehumidistats, timers, or other approved means.

B. **Intermittently Operated Whole House Ventilation Systems.** The intermittently operated whole house ventilation systems shall be constructed to have the capability for continuous operation, and shall have a manual control and an automatic control, such as a clock timer.

(f) **Noise.** Whole house fans located four feet or less from the interior grille shall have a sone rating of 1.5 or less measured at 0.1 inches water gauge. Remotely mounted fans shall be acoustically isolated from the structural elements of the building and from attached duct work using insulated flexible duct or other approved material.

EXCEPTION: Whole house ventilation systems which are integrated with forced-air heating systems or heat-recovery ventilation systems are exempt from the sone rating requirements of this section.

(g) **Ventilation Ducts.** All ducts shall terminate outside the building. Exhaust ducts in systems which are designed to operate intermittently shall be equipped with back-draft dampers. All exhaust ducts in unconditioned spaces shall be insulated to a minimum of R-4. All supply ducts in the conditioned space shall be insulated to meet a minimum of R-4. For all other ducts, see the Seattle Energy Code, Table 5-10.

(h) **Outside Air.** A. **General.** A mechanical system shall supply outside air as required in subsection (d). The mechanical system may consist of exhaust fans, supply fans, or both.

B. **Outside Air Inlets.** Inlets shall be screened or otherwise protected from entry by insects, leaves, or other material. Outside air inlets shall be located so as not to take air from the following areas:

(i) Closer than 10 feet from an appliance vent outlet, unless such vent outlet is 3 feet above the outside air inlet.

(ii) Where it will pick up objectionable odors, fumes or flammable vapors.

(iii) A hazardous or unsanitary location.

(iv) A room or space having any fuel-burning appliances therein.

(v) Closer than 10 feet from a vent opening of a plumbing drainage system unless the vent opening is at least 3 feet above the air inlet.

(vi) Attics, crawl spaces or garages.

C. **Individual Room Outside Air Inlets.** Individual room outside air inlets shall have a controllable and secure opening and be capable of a total opening area of not less than four square inches and tested by a nationally recognized standard or approved agency and located to avoid drafts.

D. **Ventilation Integrated with Forced-Air Systems.** The outside air connection to the return air stream shall be located to prevent thermal shock to the heat exchanger.

E. **Distribution.** Outside air shall be distributed to each habitable room by individual inlets, separate duct systems, or a forced-air system. Where outside air supplies are separated from exhaust points by doors, provisions shall be made to ensure air flow by undercutting doors, installation of grilles, transoms, or similar means where permitted by the Building Code.

MECHANICAL VENTILATION CRITERIA AND MINIMUM VENTILATION PRESCRIPTIVE REQUIREMENTS FOR ALL GROUP R OCCUPANCIES

Sec. 10.104 (a) **General.** This section establishes minimum prescriptive design requirements for intermittently operated systems. Continuously operated systems shall comply with Section 10.103. System characteristics not addressed in the following sections shall comply with Section 10.103. A system which meets the requirements of this section shall be deemed to satisfy the requirements of this chapter.

(b) **Source Specific.** Exhaust fans providing source specific ventilation shall have minimum fan flow rating not less than 50 CFM at 0.25 inches water gauge for bathrooms, laundries or similar rooms and 100 CFM at 0.25 inches water gauge for kitchens. Manufacturers' fan flow ratings shall be determined as per HVI Standard No. 916 (July 1989) or AMCA Standard No. 210.

(c) **Whole House.** Whole house ventilation systems may consist of whole house exhaust, integration with forced-air systems or dedicated heat recovery ventilation systems. Whole house exhaust systems shall meet the following requirements:

A. Exhaust fans providing whole house ventilation shall have a flow rating at 0.25 inches water gauge as specified in Table No. 10.1-B. Manufacturer's fan flow ratings shall be determined as per HVI Standard No. 916 (July 1989) or AMCA Standard No. 210. Table No. 10.1-B shall not be used for dwelling units with more than four bedrooms.

B. Integrated forced-air ventilation systems shall have a 6 inch diameter or equivalent outside air inlet duct connecting a terminal element on the outside of the building to the return plenum of the forced-air system. The outside air inlet duct shall be equipped with a damper or other device that regulates air flow to a minimum of 0.35 air changes per hour but not greater than 0.50 air changes per hour under normal operating conditions.

C. All duct work in heat recovery ventilation systems shall be not less than 6 inch diameter. Balancing dampers shall be installed on the inlet and exhaust side. Flow measurement grids

shall be installed on the supply and return. System minimum flow rating shall be not less than that specified in Table No. 10.1-B. Maximum flow rates in Table No. 10.1-B do not apply to heat recovery ventilation systems.

(d) **Source Specific and Whole House Exhaust Ducts.** Exhaust ducts shall meet all requirements of Section 10.103(g). Duct diameter length and number of elbows shall not be less than four inches and duct length shall not exceed levels specified in Table No. 10.1-C. Terminal elements shall have at least the equivalent net free area of the duct work.

MECHANICAL VENTILATION CRITERIA AND MINIMUM VENTILATION PERFORMANCE FOR ALL OTHER OCCUPANCIES

Sec. 10.105. Outside Air Requirements for Ventilation. Where a mechanical ventilation system is installed in lieu of natural ventilation as required by Sections 605, 705, 805, 905 and 1005 of the Building Code, the system shall be capable of supplying, or exhausting where allowed by Table No. 10.1-D, the rate of outside air specified in Table No. 10.1-D to the occupied zone during all times that the space is occupied. Occupant density shall be taken from Table No. 10.1-D.

Outside air shall be ducted in a fully enclosed path to every air handling unit in each zone not provided with sufficient openable area for natural ventilation.

EXCEPTION: Ducts may terminate within 12 inches of the intake to the HVAC unit provided they are physically fastened so that the outside air duct is directed into the unit intake.

To consider higher occupant densities, desires for higher outside air quantities per person, and HVAC systems with a ventilation effectiveness of less than 100%, the maximum total air quantities used as the basis for calculating heating and cooling design loads and for sizing HVAC equipment shall not exceed three times the quantities specified in Table No. 10.1-D.

SOLID FUEL BURNING APPLIANCES AND FIREPLACES

Sec. 10.106 (a) **General.** Solid fuel burning appliances and fireplaces shall satisfy one of the following criteria:

(b) **Solid Fuel Burning Appliances.** Solid fuel burning appliances shall be provided with the following:

1. Tight fitting glass or metal doors.

2. An outside source of combustion air directly connected to the fire box, or tested and listed to the performance requirements of the carbon monoxide test required by the Department of Housing and Urban Development Mobile Home Construction and Safety Standards.

EXCEPTION: If existing construction prohibits the introduction of outside combustion air directly to the appliance or the solid fuel burning appliance is part of the central heating system and is installed in an unconditioned space, combustion air may be supplied to the room in which the solid fuel burning appliance is located in lieu of direct ducting. The combustion air terminus shall be located as close to the

solid fuel burning appliance as possible and shall be provided with a barometric damper or equivalent. The combustion air source shall be no less than four inches in diameter or the equivalent in area or as approved.

(c) **Fireplaces.** Fireplaces shall be provided with each of the following:

1. Tightly fitting flue dampers, operated by a readily accessible manual or approved automatic control.

2. An outside source for combustion air ducted into the firebox. The duct shall be at least six square inches, and shall be provided with an operable outside air duct damper.

3. Tightly fitting glass or metal doors, or flue draft induction fan or as approved for minimizing back-drafting.

EXCEPTION: Fireplaces with gas logs shall be installed in accordance with Chapter 8.

MINIMUM SOURCE SPECIFIC VENTILATION CAPACITY REQUIREMENTS
TABLE 10.1-A

	Bathrooms	Kitchens
Intermittently operating	50 cfm	100 cfm
Continuous operation	20 cfm	25 cfm

WHOLE HOUSE EXHAUST FAN PRESCRIPTIVE REQUIREMENTS
TABLE 10.1-B

Bedrooms	CFM Minimum	CFM Maximum
2 or less	50	75
3	80	120
4	100	150

PRESCRIPTIVE EXHAUST DUCT SIZING
TABLE 10.1-C

Fan Tested CFM @0.25 W.G.	Maximum Flex Diameter	Maximum Length Feet	Maximum Smooth Diameter	Maximum Length Feet	Maximum Elbows*
50	4 inch	25	4 inch	70	3
50	5 inch	90	5 inch	100	3
50	6 inch	Over 100	6 inch	Over 100	3
80	4 inch	Not Allowed	4 inch	20	3
80	5 inch	15	5 inch	100	3
80	6 inch	90	6 inch	Over 100	3
100	5 inch	Not Allowed	5 inch	50	3
100	6 inch	45	6 inch	Over 100	3
125	6 inch	15	6 inch	Over 100	3
125	7 inch	70	7 inch	Over 100	3

*For each additional elbow subtract 10 feet from length.

TABLE 10.1-D
OUTSIDE AIR REQUIREMENTS FOR VENTILATION[1]

Application	Estimated Maximum Occupancy, persons per 1000 ft² of net occupiable space	Outdoor Air Requirements
COMMERCIAL		
		cfm/person
Dry Cleaners, Laundries[3]		
Commercial laundry	10	25
Commercial dry cleaner	30	30
Storage, pick up	30	35
Coin-operated laundries	20	15
Coin-operated dry cleaner	20	15
Food and Beverage Service		
Dining rooms	70	20
Cafeteria, fast food	100	20
Bars, cocktail lounges[4]	100	30
Kitchens (cooking)[5]	20	15
Garages, Repair, Service Stations[6]		**cfm/ft² floor**
Enclosed parking garage		1.50
Auto repair rooms		1.50
Hotels,Motels,Resorts, Dormitories[7]		
For Group R Occupancy, see requirements in Sections 10.103 and 10.104		
		cfm/person
Lobbies	30	15
Conference rooms	50	20
Assembly rooms	120	15
Dormitory sleeping areas	20	15
Gambling casinos[4]	120	30
Offices[10]		
Office space	7	20
Reception areas	60	15
Telecommunication centers and data entry areas	60	20
Conference rooms[4]	50	20
Public Spaces		**cfm/ft²**
Corridors and utilities		0.05
		cfm/wc or urinal

TABLE 10.1-D (continued)
OUTSIDE AIR REQUIREMENTS FOR VENTILATION[1]

Application	Estimated Maximum Occupancy, persons per 1000 ft^2 of net occupiable space	Outdoor Air Requirements
COMMERCIAL (cont.)		
Public restrooms[11]		50 **cfm/ft^2**
Locker and dressing rooms		0.5 **cfm/person**
Smoking lounge[12]	70	60 **cfm/ft^2**
Elevators[13]		1.00
Retail Stores,Sales Floors, and Show Room Floors		**cfm/ft^2**
Basement and street	30	0.30
Upper floors	20	0.20
Storage rooms	15	0.15
Dressing rooms		0.20
Malls and arcades	20	0.20
Shipping and receiving	10	0.15
Warehouses	5	0.05
Smoking lounge[12]	70	**cfm/person** 60
Specialty Shops		
Barber	25	15
Beauty	25	25
Reducing salons	20	15
Florists[14]	8	15
Clothiers, furniture		**cfm/ft^2** 0.30
Hardware, drugs, fabric	8	15
Supermarkets	8	15
Pet shops		**cfm/ft^2** 1.00
Sports and Amusements[15]		**cfm/person**
Spectator areas	150	15
Game rooms	70	25
Ice arenas(playing areas)		**cfm/ft^2** 0.50
Swimming pools(pool & deck area)[16]		0.50 **cfm/person**

TABLE 10.1-D (continued)
OUTSIDE AIR REQUIREMENTS FOR VENTILATION[1]

Application	Estimated Maximum Occupancy, persons per 1000 ft^2 of net occupiable space	Outdoor Air Requirements
COMMERCIAL (cont.)		
Playing floors (gymnasium)	30	20
Ballrooms and discos	100	25
Bowling alleys (seating areas)	70	25
Theaters[17]		
Ticket booths	60	20
Lobbies	150	20
Auditorium	150	15
Stages, studios	70	15
Transportation[18]		
Waiting rooms	100	15
Platforms	100	15
Vehicles	150	15
Workrooms		
Meat processing[19]	10	15
Photo studios	10	15
		cfm/ft^2
Darkrooms	10	0.50
		cfm/person
Pharmacy	20	15
Bank vaults	5	15
		cfm/ft^2
Duplicating, printing[20]		0.50
INSTITUTIONAL		
		cfm/person
Education		
Classroom	50	15
Laboratories[21]	30	20
Training shop	30	20
Music rooms	50	15
Libraries	20	15
		cfm/ft^2
Locker rooms		0.50
Corridors		0.10
		cfm/person
Auditoriums	150	15
Smoking lounges[12]	70	60
Hospitals, Nursing and Convalescent Homes[22]		
		cfm/person
Patient rooms	10	25
Medical procedure	20	15
Operating rooms	20	30
Recovery and ICU	20	15
		cfm/ft^2
Autopsy rooms		0.50
		cfm/person
Physical Therapy	20	15
Correctional Facilities		
Cells	20	20
Dining halls	100	15
Guard stations	40	15

CS 19.2

TABLE 10.1-D (continued)
OUTSIDE AIR REQUIREMENTS FOR VENTILATION[1]

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[1] From ASHRAE Standard 62-1989. This table prescribes supply rates of acceptable outside air required for acceptable indoor air quality. These values have been chosen to control CO_2 and other contaminants with an adequate margin of safety and to account for health variations among people, varied activity levels, and a moderate amount of smoking. Rationale of CO_2 control is presented in ASHRAE Standard 62-1989.

[2] Independent of room size; installed capacity for intermittent use.

[3] Dry-cleaning processing may require more air.

[4] Supplementary smoke-removal equipment may be required.

[5] Makeup air for hood exhaust may require more ventilating air. The sum of the outside air and transfer air of acceptable quality from adjacent spaces shall be sufficient to provide an exhaust rate of not less than 1.5 cmf/ft^2.

[6] Distribution among people must consider worker location and concentration of running engines; stands where engines are run must incorporate systems for positive engine exhaust withdrawal. Contaminant sensors may be used to control ventilation.

[7] See also food and beverage services, merchandising, barber and beauty shops, garages.

[8] Independent of room size.

[9] Installed capacity for intermittent use.

[10] Some office equipment may require local exhaust.

[11] Mechanical exhaust with no recirculation.

[12] Normally supplied by transfer air, local mechanical exhaust with no recirculation recommended.

[13] Normally supplied by transfer air.

[14] Ventilation to optimize plant growth may dictate requirements.

[15] When internal combustion engines are operated for maintenance of playing surfaces, increased ventilation rates may be required.

[16] Higher values may be required for humidity control.

[17] Special ventilation will be needed to eliminate special stage effects (e.g., dry ice vapors, mists, etc.)

[18] Ventilation within vehicles may require special considerations.

[19] Spaces maintained at low temperatures (-10°F to +50°F) are not covered by these requirements unless the occupancy is continuous. Ventilation from adjoining spaces is permissible. When the occupancy is intermittent, infiltration will normally exceed the ventilation requirement.

TABLE 10.1-D (continued)
OUTSIDE AIR REQUIREMENTS FOR VENTILATION[1]

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[20] Installed equipment must incorporate positive exhaust and control (as required) of undesirable contaminants (toxic or otherwise).

[21] Special contaminant control systems may be required for processes or functions including laboratory animal occupancy.

[22] Special requirements or codes and pressure relationships may determine minimum ventilation rates and filter efficiency. Procedures generating contaminants may require higher rates.

[23] Air shall not be recirculated into other spaces.

Section 48: As of July 1, 1991, Section 605 of the Seattle Building Code as adopted by Ordinances 113700 and 113701 is amended as follows:

Sec. 605. All enclosed portions of Group A Occupancies customarily used by human beings and all dressing rooms shall be provided with natural light by means of exterior glazed openings with an area not less than one tenth of the total floor area, and natural ventilation by means of openable exterior openings with an area of not less than one twentieth of the total floor area or shall be provided with artificial light and a mechanically operated ventilating system. The mechanically operated ventilating system shall comply with the requirements set forth in ((~~Section 303~~)) Chapter 10.1 ((~~of the Seattle Energy Code~~)) and applicable requirements of the Seattle Mechanical Code. ((~~Such system shall be kept continuously in operation during such time as that portion of the building is occupied.~~))

Toilet rooms shall be provided with a fully openable exterior window at least 3 square feet in area; or a vertical duct not less than 100 square inches in area for the first toilet facility, with 50 additional square inches for each additional facility; or a mechanically operated exhaust system capable of providing a complete change of air every 15 minutes. Such systems shall be connected directly to the outside, and the point of discharge shall be at least 5 feet from any openable window. There shall be provided in an approved location at least one lavatory for each two water closets for each sex and at least one drinking fountain for each floor level. For other requirements on water closets, see Sections 510 and 511.

Section 49: As of July 1, 1991, Section 705 of the Seattle Building Code as adopted by Ordinances 113700 and 113701 is amended as follows:

Sec. 705. In Group B Occupancy buildings, all enclosed portions customarily occupied by human beings, other than rooms and areas for which requirements are specified elsewhere in this section, shall be provided with natural light by means of exterior glazed openings with an area equal to one tenth of the total floor area of such portions, and natural ventilation by means of

exterior openings with an openable area not less than one twentieth of the total floor area of such portions, or shall be provided with artifical light and a mechanically operated ventilating system. The mechanically operated ventilation system shall comply with the requirements set forth in ((~~Section 303~~)) Chapter 10.1 ((~~of the Seattle Energy Code~~)) and applicable requirements of the Seattle Mechanical Code.

In all buildings or portions thereof where Class I, II or III-A liquids are used, exhaust ventilation shall be provided sufficient to product four air changes per hour. Such exhaust ventilation shall be taken from a point at or near the floor level.

In all parking garages other than open parking garages as defined in Section 709(b), used for storing or handling of automobiles operating under their own power and on all loading platforms in bus terminals, ventilation shall comply with the requirements set forth in ((~~Section 303~~)) Chapter 10.1 ((~~of the Seattle Energy Code~~)) and applicable requirements of the Seattle Mechanical Code. The building official may approve an alternate ventilation system designed to exhaust a minimum of 14,000 cfm for each operating vehicle. Such system shall be based upon the anticipated instantaneous movement rate of vehicles but not less than 2.5 percent (or one vehicle) of the garage capacity. Automatic CO sensing devices may be employed to modulate the ventilation system to maintain a maximum average concentration of Co of 50 ppm during any eight hour period, with a maximum concentration of not greater than 200 ppm for a period not exceeding one hour. Connecting offices, waiting rooms, ticket booths, etc., shall be supplied with conditioned air under positive pressure.

* * *

Section 50: As of July 1, 1991, Section 905 of the Seattle Building Code as adopted by Ordinances 113700 and 113701 is amended as follows:

Sec. 905. In Group H Occupancy buildings, all enclosed portions customarily occupied by human beings, other than rooms and areas for which requirements are specified elsewhere in this section, shall be provided with natural light by means of exterior glazed openings with an area equal to one tenth of the total floor area of such portions, and natural ventilation by means of exterior openings with an openable area not less than one twentieth of the total floor area of such portions, or shall be provided with artificial light and a mechanically operated ventilating system. The mechanically operated ventilation system shall ((~~be capable of supplying a minimum of 5 cubic feet permit minute of outside air with a total circulated of not less than 15 cubic feet per minute per occupant in all occupied portions of the building~~)) comply with the requirements set forth in Chapter 10.1 and applicable requirements of the Seattle Mechanical Code.

In all buildings or portions thereof where Class I, II or III-A liquids are used, mechanical exhaust ventilation shall be provided sufficient to produce four complete air changes per hour. Higher ventilation rates may be required by the Fire Code. Such exhaust ventilation shall be taken from a point at or near the floor level.

In all buildings used for the repair or handling of automobiles operating under their own power, mechanical ventilation shall comply with the requirements set forth in ((~~Section 303~~)) Chapter 10.1 ((~~of the Seattle Energy Code~~)) and applicable requirements of the Seattle Mechanical Code. Additionally, each engine repair stall shall be equipped with an exhaust pipe extension duct, extending to the outside of the building, which, if over 10 feet in length, shall mechanically exhaust 300 cubic feet per minute. Connecting offices and waiting rooms shall be supplied with conditioned air under positive pressure.

Section 51: As of July 1, 1991, Section 1205 of the Seattle Building Code as adopted by Ordinances 113700 and 113701 is amended as follows:

Sec. 1205. (a) **Light and Ventilation.** All guest rooms, dormitories and habitable rooms except kitchens within a dwelling unit shall be provided with natural light by means of exterior glazed openings with an area not less than one tenth of the floor area of such rooms with a minimum of 10 square feet. All bathrooms, water closet compartments, laundry rooms and similar rooms shall be provided with natural ventilation by means of openable exterior openings with an area not less than one twentieth of the floor area of such rooms with a minimum of 1½ square feet.

All guest rooms, dormitories and habitable rooms within a dwelling unit shall be provided with natural ventilation by means of openable exterior openings with an area of not less than one twentieth of the floor area of such rooms with a minimum of 5 square feet.

Mechanical ventilation shall be provided as required by Chapter 10.1 of the Seattle Mechanical Code. This system may serve in lieu of required exterior openings for natural ventilation. ((~~, a mechanical ventilating system may be provided. Such system shall comply with the requirements set forth in Section 303 of the Seattle Energy Code and applicable requirements of the Mechanical Code in all guest rooms, dormitories, habitable rooms and in public corridors. In bathrooms, water closet compartments, laundry rooms and similar rooms a mechani-cal ventilation system connected directly to the outside, shall be provided.~~))

For the purpose of determining light and ventilation requirements, any room may be considered as a portion of an adjoining room when one half of the area of the common wall is open and unobstructed and provides an opening of not less than one tenth of the floor area of the interior room or 25 square feet, whichever is greater.

Required exterior openings for natural light and ventilation shall open directly onto a street or public alley or a yard or court located on the same lot as the building.

EXCEPTION: Required windows may open into a roofed porch where the porch:

1. Abuts a street, yard or court; and
2. Has a ceiling height of not less than 7 feet; and

3. Has the longer side at least 65 percent open and unobstructed.

* * *

Section 52: As of July 1, 1991, a new Section 1720 is added to the Seattle Building Code as adopted by Ordinances 113700 and 113701 as follows:

Sec. 1720 (a) **General.** The criteria of this section establish minimum radon resistive construction requirements for all Group R Occupancies.

(b) **Radon Monitoring.** A three month etched track radon monitor, installation instructions, and radon information sheets shall be provided by the builder at the final inspection to all single family residences and to all first floor dwelling units in multi-unit residential structures. It is not the responsibility of the builder to administer the radon test.

(c) **Crawl Spaces.** All crawl spaces shall be ventilated as specified in Section 2516 (c).

If the installed ventilation in a crawl space is less than 1 square foot for each 300 square feet of crawl space area, or if the crawl space vents are equipped with operable louvers, a radon vent shall be installed from a point between the ground cover and soil. The radon vent shall be installed in accordance with Section 1720 (d) Item 5.

(d) **Crawl Space Plenum Systems.** 1. **General.** In crawlspace plenum systems used for providing supply or return air for an HVAC system, aggregate, sealings, a soil gas retarder membrane and a radon vent pipe shall be installed in accordance with this section.

In addition, a radon vent fan shall be installed and activated. The fan shall be located as specified in this section. The fan shall be capable of providing at least 100 CFM at one inch water column static pressure.

2. **Aggregate.** A layer of aggregate of 4-inch-minimum thickness shall be placed beneath the concrete slab. The aggregate shall be continuous to the extent practical. Aggregate shall:

A. Comply with U.B.C. Standard No. 26-2 and shall be No. 67 or larger size aggregate as listed in Table 26-2-A, Grading Requirements for Concrete Aggregates; or

B. Meet the 1988 Washington State Department of Transportation specification 9-03.1 (3) "Coarse Aggregate for Portland Cement Concrete", or any equivalent successor standards. Aggregate size shall be of Grade 5 or larger as listed in section 9-03.1 (3) C, "Grading"; or

C. Be screened, washed and free of deleterious substances in a manner consistent with U.B.C. Standard No. 26-2 with 100

percent of the gravel passing a one inch sieve and less than 2 percent passing a 4-inch sieve. Sieve characteristics shall conform to those acceptable under U.B.C. Standard No. 26-2.

EXCEPTION: Aggregate shall not be required if a substitute material or system, with sufficient load bearing characteristics, and having approved capability to provide equal or superior air flow, is installed.

3. **Soil-Gas Retarder Membrane.** A soil-gas retarder membrane, consisting of at least one layer of virgin polyethylene with a thickness of at least 6 mil, or equivalent flexible sheet material, shall be placed directly under the concrete slab. The flexible sheet shall extend to the foundation wall or to the outside edge of the monolithic slab. Seams shall overlap at least 12 inches.

4. **Sealing of Penetrations and Joints.** All penetrations and joints in concrete slabs or other floor systems and walls below grade that will not be accessible at the time the certificate of occupancy is granted shall be sealed by an approved sealant to create an air barrier to limit the movement of soil gas into the indoor air.

Sealants shall be approved by the manufacturer for the intended purpose. Sealant joints shall conform to manufacturer's specifications. The sealant shall be placed and tooled in accordance with manufacturer's specifications. There shall be no gaps or voids after the sealant has cured.

Concrete block walls connected to below grade areas shall be considered unsealed surfaces. All openings in concrete block walls that will not remain accessible upon completion of the building shall be sealed at both vertical and horizontal surfaces, in order to create a continuous air barrier to limit the transport of soil gas into the indoor air.

5. **Radon Vent.** One continuous sealed pipe shall run from a point within the aggregate under each concrete slab to a point outside the building. Joints and connections shall be gas tight.

The continuous sealed pipe shall terminate no less than 12 inches above the eave, and more than 10 horizontal feet from a woodstove or fireplace chimney, or operable window. The continuous sealed pipe shall be labeled **"Radon Vent"**. The label shall be placed so as to remain visible to an occupant.

The minimum pipe diameter shall be 3 inches unless otherwise approved. Acceptable sealed plastic pipe shall be smooth walled, and may include either PVC schedule 40 or ABS schedule of equivalent wall thickness.

The entire sealed pipe system shall be sloped to drain. The exterior pipe opening shall be protected from blockage by snow accumulation.

The sealed pipe system may pass through an unconditioned attic before exiting the building; but to the extent practicable, the sealed pipe shall be located inside the thermal envelope of the building in order to enhance passive stack venting.

EXCEPTION: A radon vent shall not be required if a fan-forced sub-slab depressurization system is installed. A fan-forced sub-slab depressurization system includes:

1. soil-gas retarder membrane as specified in section (d) 3;

2. sealing of penetrations and joints as specified in section (d) 4;

3. a 3 inch continuous sealed radon pipe which shall run from a point within the aggregate under each concrete slab to a point outside the building;

4. joints and connections which shall be gas tight, and may be of either PVC schedule 40 or ABS schedule of equivalent wall thickness;

5. a label of "Radon Vent" which shall be placed on the pipe so as to remain visible to the occupant;

6. and fan circuit and wiring as specified in section (d) 6 and a fan.

If the sub-slab depressurization system is exhausted through the concrete foundation wall or rim joist, the exhaust terminus shall be a minimum of six feet from operable windows or outdoor air intake vents and shall be directed away from operable windows and outdoor air intake vents to prevent radon re-entrainment.

6. **Fan Circuit and Wiring and Location.** An area for location of an in-line fan shall be provided. The location shall be as close as practicable to the radon vent pipe's point of exit from the building, or shall be outside the building shell. It shall be located so that the fan and all downstream piping is isolated from the indoor air.

Provisions shall be made to allow future activation of an in-line fan on the radon vent pipe without the need to place new wiring. A 110 volt power supply shall be provided at a junction box near the fan location.

7. **Separate Aggregate Areas.** If the 4 inch aggregate area underneath the concrete slab is not continuous, but is separated into distinct isolated aggregate areas by a footing or other barrier, a minimum of one radon vent pipe shall be installed into each separate aggregate area.

EXCEPTION: Separate aggregate areas may be considered a single area if a minimum 3 inch diameter connection joining the separate areas is provided for every 30 feet of barrier separating those areas.

Section 53: As of July 1, 1991, a new Section 1721 is added to the Seattle Building Code as adopted by Ordinances 113700 and 113701 as follows:

Sec. 1721. Formaldehyde Reduction Measures. In all Group R Occupancies all structural panel components of the structure such as softwood plywood, particle board, wafer board, and oriented strand board shall be identified as "EXPOSURE 1", "EXTERIOR" or "HUD APPROVED".

Section 54: As of July 1, 1991, Section 22.100.010 SMC, as last amended by Ordinance 113700, is further amended as follows:

22.100.010 Adoption of Uniform Building Code.

The Uniform Building Code, 1985 edition, except Chapters 1, 2 and 3, published by the International Conference of Building Officials, one (1) copy of which is filed with the City Comptroller (C.F. 295997), is adopted and by this reference made part of this subtitle and together with the amendments adopted by Ordinances 113701 and _____, shall constitute the Seattle Building Code.

Section 55: As of July 1, 1991, Section 22.400.010 SMC, as last amended by Ordinance 113702, is further amended as follows:

22.400.010 Adoption of Uniform Mechanical Code.

The Uniform Mechanical Code, 1985 Edition, together with its standards and appendices, and except for Chapters 1, 2 and 3, published by the International Conference of Building Officials and the International Association of Plumbing and Mechanical Officials, one (1) copy of which is filed with the City Comptroller (C.F. 295995), is adopted and by this reference made part of this subtitle and together with the amendments adopted by Ordinances 113703 and _____, shall constitute the Seattle Mechanical Code.

Section 56: The amendment of SMC 22.700.010, SMC 22.100.010 and 22.400.010 shall not affect any right accrued, any time limit for compliance, any penalty incurred or any proceeding commenced under or by the superseded provisions.

Section 57. The provisions of this ordinance are declared to be separate and severable. The invalidity of any clause, sentence, paragraph, subdivision, section or portion of this ordinance, or the invalidity of the application thereof to any person, owner, or circumstance shall not affect the validity of the remainder of this ordinance, or the validity of its application to other persons, owners or circumstances.

Section 58. This ordinance shall take effect and be in force thirty days from and after its passage and approval, if approved by the Mayor; otherwise it shall take effect at the time it shall become a law under the provisions of the city charter.

Passed by the City Council the 13th day of May, 1991, and signed by me in open session in authentication of its passage this 13th day of May, 1991.

President of the City Council.

Approved by me this 17th day of May, 1991.

Norman B. Rice
Mayor.

Filed by me this 20th day of May, 1991.

Attest: Norma J. Brooks
City Comptroller and City Clerk.

(SEAL)

Published ..... By Margaret Carter
Deputy Clerk.

City of Seattle

Executive Department-Office of Management and Budget

Andrew J. Lofton, Director
Norman B. Rice, Mayor

April 1, 1991

Please see attached memorandum 4/2/91

The Honorable Mark Sidran
City Attorney
City of Seattle

Dear Mr. Sidran:

The Mayor is proposing to the City Council that the enclosed legislation be adopted.

REQUESTING DEPARTMENT: Construction and Land Use

SUBJECT: AN ORDINANCE relating to energy-efficiency, energy conservation, indoor air quality and ventilation in building construction; amending Section 22.700.010 Seattle Municipal Code ("SMC") to adopt by reference the 1989 Model Energy Code; amending Sections 101, 103, 104, 105, 106, 201, 302, 303, 401, 402, 502, 503, 504, and 505 and Chapters 4, 5 and 7, repealing Section 403, Chapter 6, and the Appendix, adding new Sections 107, 108, 109, 202 and new Chapters 8, 9 and 10 to incorporate the minimum requirements of the 1991 Washington State Energy Code (Chapter 51-11 WAC) and the Washington State Water Conservation Performance Standards (SHB 1397 and WAC 51-18), and to revise the requirements for Other than Group R Occupancy; amending Sections 403, 404, 405, 406, 408, 410, 415, 417, 420, 421, 422, 423, 424, 425, 426, 601, 602, and 604 of the Seattle Mechanical Code and adding a new Chapter 10.1 to the Seattle Mechanical Code to incorporate the 1991 Washington State Ventilation and Indoor Air Quality Code (Chapter 51-13 WAC); amending Sections 605, 705, 905 and 1205 of the Seattle Mechanical Code and to incorporate provisions of the 1991 Washington State Ventilation and Indoor Air Quality Code; and amended SMC Sections 22.100.010 and 22.400.010.

Pursuant to the City Council's S.O.P. 100-014, the Executive Department is forwarding this request for legislation to your office for review and drafting.

After reviewing this request and any necessary redrafting of the enclosed legislation, return the legislation to OMB. Any specific questions regarding the legislation can be directed to Victoria Runkle at 4-8088.

COPY RECEIVED
APR -2 PM 2:27
SEATTLE CITY ATTORNEY

Sincerely,

Norman B. Rice
Mayor

by
ANDREW J. LOFTON
Budget Director

AL/vr/rsf

Enclosure

cc: Director, Department of Construction and Land Use

FAX TRANSMITTAL

Iverson Elder Inc.

Mechanical Systems Engineers

Phone 206-483-1250
FAX 206-487-1825

Date: 4/30/91

FAX No.: 628-5067

Company: UNICO

Attention: Bob Messer

Subject: 1991 Seattle Energy Code

IEi Job No.:

We are transmitting 1 page(s) including this transmittal cover. If you do not receive all of the pages, please call back as soon as possible at 483-1250.

Bob,

I hope it's not too late to give you a comment for Sam Smith at the hearing. In addition to our discussion the other day, if I was there tomorrow I would try to emphasize that the 1991 code is first of all based on ASHRAE Standard 90.1, which is a national, "consensus" standard. In other words, this represents our best consensus in the engineering community of what current energy efficiency should be. While the standard was controversial, it was developed over a period of almost ten years (1980 to late 1989) and went through three (3) national public review drafts. DCLU codified this national consensus standard, and then our various committees met literally dozens of times and had hundreds of conversations and discussions. Our meetings were open to the public, and when we encountered areas in the draft code that might be controversial with a particular group, we invited them to participate and give input. An example of this is the issue of insulating warehouses that are kept at lower temperatures than normal comfort heating conditions. The new standard would have required fully insulating these buildings, which some of the contractors argued would increase the costs dramatically. In response to their concerns and a considerable amount of cost analysis, provided by them and the commercial committee, we achieved a compromise which resulted in a new code definition of "semi-heated space," which allows for the uniqueness of warehouses, but is not as stringent as normally conditioned space. This is just one example (and I know you have many from your subcommittee) of the kind of community input that went into this document. So even more than the original standard developed by ASHRAE, we believe this code substantially represents a Seattle community consensus. I believe a lot of the cooperation was achieved because the computer modeling requirement has been removed. That was previously the most controversial part of the code. Some of us would have gone along with anything to get rid of that. The longer code implementation is delayed, the longer we have to do computer modeling. Not pushing this code through could ultimately be most controversial thing that could occur!

Copy to

Keith E. Elder, P.E.

Telecopy Operator
Susan Huntley

ADDENDUM TO ESTIMATES OF COST IMPACTS
FOR AMENDMENTS TO THE 1991 SEATTLE ENERGY CODE
(AND ACCOMPANYING CHANGES TO THE SEATTLE MECHANICAL CODE
AND THE SEATTLE BUILDING CODE)
15 March 1991

This addendum provides cost estimates due to adoption of the 1991 Washington State Energy Code and the 1991 Washington State Ventilation and Indoor Air Quality Code. These costs are in addition to those included in the December 1990 Estimate of Cost Impacts. There are projected additional one-time or first year costs in items 1, 6, 7 and 10e for a total of $35000. Ongoing costs are included in item 10c for a total of $30000 and approximately 0.25 FTE staff.

Task		Hours	Costs
1.	Training		
	c. Receive training		
	Staff training		
	Sgl. family plans examiners (8 x 1hr)	8	568
	Multi fam. plans examiners (5 x 1hr)	5	355
6.	Public Information		
	a. Revised bulletin preparation		
	303 Plan Req'ments for Single Family	10	710
7.	New Forms		
	a. Revise forms		
	Target UA Form (4 pp)	10	710
	Plan Cover Sheets (3 pp @ 24 x 36)	10	710
	b. Copy forms		
	4 pages x $0.04/page x 500 copies		80
	3 pages x $1.00/page x 500 copies		1500
10.	Plan Review Time		
	c. Additional review		
	More careful checking of window specifications, new review for mechanical ventilation, radon and formaldehyde requirements		
	New sgl family (700 x 5 min/proj)	58	4118
	New multi fam (180 x 5 min/proj)	15	1065
	Existing resid (2100 x 10 min/proj)	350	24850
	e. Learning curve (first-year costs)		
	Assumed to be double additional review time above for first year		
	Thus additional time and cost	423	30033
TOTAL ADDITIONAL			
	a. One-time or first-year costs	466	34666
	b. Ongoing costs/year	423	30033

Task	Hours	Costs
Existing buildings (2511 x 3 min/project)	126	8946
Mechanical permits (780 x 3 min/project)	39	2769
Electrical permits (6 major projects x 30 min/project)	3	213
e. Learning curve (first-year costs) First year time for review is assumed to be double the ongoing time cited above under More Complex Rules (for all projects except new major projects). Thus the additional time and cost	183	12993
11. DCLU Automated System		
a. New or revised screens Add new screen for major projects under address code so plans examiners and inspectors can quickly identify what standards to use for main building permit and all tenant improvement plans (especially for lighting) which will follow. Also generate monthly reports summarizing project activity.		
New screen	50	5000
Monthly reports	4	284
b. New Codes		
12. Enforcement		
a. Caseload increase None		
b. Effects on Municipal Court None		
13. Inspections Impacts		
a. New special inspections None		
b. More items to input See new type of inspection		
c. New type of inspection The ten major projects (2 million square feet) per year have currently had a variety of special features requiring inspection. We expect that the majority of these projects will now follow more of a standard path, thereby reducing the overall number of new types of inspection. This will be offset by new requirements for variable speed drive for some large motors and for minimum motor efficiency, and lower allowed office lighting wattages for major projects. Net impact:		

Task	Hours	Costs
Mechanical inspections (100 x 5 min/project)	8	568
Electrical inspections (600 x 5 min project)	50	3550

14. Records Management/Microfilm
Will it require substantially more filing space?
None

15. New Types of-Permits
None

16. Space and Equipment Costs
a. Space costs for new staff or equipment
None
b. Cost of new equipment
None

JH:rm
901129
I:90-ENERGY.CPT/estim.1 - estim.7

Seattle
Department of Construction and Land Use

Dennis J. McLerran, Director
Norman B. Rice, Mayor

RECEIVED OMB
MAR 2 8 1991
849558

TO: Andrew Lofton, Director
Office of Management and Budget

ATTN: Victoria Runkle, Budget Analyst

FROM: Dennis J. McLerran, Director D.J.M.

DATE: March 29, 1991

SUBJECT: Revised Transmittal of Proposed Revisions to the Seattle Energy Code

On January 3, 1991, we forwarded to you proposed revisions to the Seattle Energy Code. Attached is a revised package of material. State law mandates that certain of these requirements be enforced no later than July 1, 1991. We hope that it is now possible to forward the proposal to the City Council quickly.

The proposal includes a substitute ordinance and supplementary material for the cover memo, summary of code changes and the cost report.

The proposed ordinance has been revised based on comments from the Law Department. Also included are minimum requirements from the Washington State Energy Code and the Ventilation and Indoor Air Quality Code. This ordinance is a replacement for the one you received earlier.

Supplementary material in the cover memo, summary of code changes and cost report provides information on the impacts of the Washington State Code changes which we are required to enforce. This material should be forwarded in addition to, not instead of, the previous information.

John Hogan of our Code Development and Coordination staff has spoken with Mona Goode on the January 3, 1991 package and Victoria Runkle on this package. He remains the DCLU project manage for this proposal. If you have any questions, please call him at 386-9145 or his supervisor Kermit Robinson at 386-9146.

Included with this material is a memorandum to the Law Department. Please make sure this goes with your transmittal of this proposal to the Law Department as it will help expedite its review.

Seattle
Department of Construction and Land Use

Dennis J. McLerran, Director
Norman B. Rice, Mayor

TO: Mark Sidran, City Attorney

ATTN: Pat Schneider

FROM: Dennis J. McLerran, Director

DATE: March 28, 1991

SUBJECT: Amended Version of Proposed Revisions to the Seattle Energy Code

Attached for your review is an amended version of the proposed revisions to the Seattle Energy Code (and accompanying changes to the Seattle Mechanical Code and the Seattle Building Code) which were initially forwarded on January 3, 1991. This package includes certain Washington State Energy Code and Ventilation and Indoor Air Quality Code requirements that we must enforce July 1, 1991.

John Hogan of our Code Development and Coordination staff has been working with Margaret Klockars on this proposal. We believe that we have responded to her concerns, both in the initial proposal and in the development of this amended proposal.

To allow adequate time for printing, staff and public training, etc., we are anxious to have the City Council consider this material as soon as possible. If you have any questions, please call John Hogan at 386-9145 or his supervisor Kermit Robinson at 386-9146.

Seattle
Department of Construction and Land Use

Dennis J. McLerran, Director
Norman B. Rice, Mayor

M E M O R A N D U M

TO: Mayor Norman B. Rice
via Andrew Lofton, OMB

FROM: Dennis J. McLerran, Director,
Department of Construction and Land Use
Randall W. Hardy, Superintendent,
Seattle City Light

DATE: March 27, 1991

SUBJECT: Adoption of Minimum Requirements in the Washington State Energy Code and Ventilation and Indoor Air Quality Code

With this memorandum we are transmitting to you revisions to the Seattle Energy Code (with accompanying modifications to the Seattle Mechanical Code and the Seattle Building Code) to comply with changes to State law. This proposal incorporates the requirements of the Washington State Energy Code and Ventilation and Indoor Air Quality Code.

State law requires that these revisions be enforced no later than July 1, 1991. The ordinance proposed establishes an effective date of July 1, 1991. Because of public information needs, we would appreciate consideration and action as soon as possible.

The State law changes primarily affect residential (Group R Occupancy) buildings. Major features include:

* Better windows for all Group R Occupancy.
* More floor insulation and insulated doors for Group R Occupancy with electric heat.
* Many more prescriptive options for simpler building envelope compliance.
* Higher minimum efficiencies for furnaces and heat pumps.
* Mechanical ventilation for all Group R Occupancy.

* Minimum requirements for radon mitigation and limits on formaldehyde in building materials.

* Stringent requirements for change of occupancy and use.

Strictly interpreted, one subsection of the State law requires that when there are changes of use (such as from commercial to residential or vice versa or adding mechanical cooling), then the building must be brought up to the energy standards for new construction. Another subsection requires that initial tenant alterations comply with the new construction requirements. In fact, however, the controlling section allows the building official under certain conditions to approve changes when the energy-efficiency is improved and the change is necessary for the welfare of the general public. We believe that this section gives us the authority we need to address special cases so as to achieve continuing utilization of existing buildings.

More detail on the State law changes only is contained in the attached Section by Section Summary and Cost Report. The Cost Report estimate is for an additional one-time or first-year costs of $35,000, and an ongoing cost of $30,000 and approximately 0.25 FTE staff.

The attached ordinance, however, includes both these changes and other changes which primarily affect commercial buildings. Those changes are discussed in our earlier cover memo (January 3, 1991), Section by Section Summary (December 1990) and Cost Report (December 1990).

State law requires that the Bonneville Power Administration provide a payment to builders who construct electrically-heated residential structures. This payment is made through the local utility. DCLU and Seattle City Light are exploring the most satisfactory means to accomplish this.

As indicated in our January 3, 1991 cover memo, a declaration of non-significance was issued in October 1990 for our earlier proposal and no appeals were submitted. This amended proposal is required by State law and thus is exempt as an administrative action.

To allow adequate time for printing, revising forms, preparing public information, staff and public training, etc., we are anxious to have the City Council consider this material as soon as possible. Please call John Hogan at 386-9145 if you have any questions.

Seattle
Department of Construction and Land Use

Dennis J. McLerran, Director
Norman B. Rice, Mayor

91 JAN -9 PM 2:49
SEATTLE CITY ATTORNEY

RECEIVED OMB
JAN - 3 1991

TO: Andrew Lofton, Director
Office of Management and Budget

ATTN: Mona Goode, Budget Analyst

FROM: Dennis J. McLerran, Director D.J.M.

848472

DATE: January 3, 1991

RE: Transmittal of Proposed Revisions to Energy Code

Attached for your review is the proposed readoption of the Seattle Energy Code. The proposal was developed by this department in conjunction with City Light. We hope you will forward the proposal to City Council at your earliest convenience.

The attached memorandum summarizes the proposal and includes a summary of the budgetary impacts of the proposal. This is followed by two ordinances. The shorter will adopt the Model Energy Code by reference. The longer ordinance adopts the local amendments to the model code. (Two extra copies of the ordinances are also included.) This two ordinance format is required by the Law Department when adopting and amending model codes.

John Hogan of our Code Development and Coordination staff has spoken with Mona Goode on this proposal. He will be the DCLU project manager for this proposal. If you have any questions please call him at 386-9145, or his supervisor, Kermit Robinson at 386-9146.

Included with this material is a memorandum to the Law Department. Please make sure this goes with your transmittal of this proposal to the Law Department as it will help expedite its review.

Seattle
Department of Construction and Land Use

Dennis J. McLerran, Director
Norman B. Rice, Mayor

RECEIVED
91 JAN -9 PM 2:49
SEATTLE CITY ATTORNEY

TO: Mark Sidran, City Attorney

ATTN: Pat Schneider

FROM: Dennis J. McLerran, Director D.J.M.

DATE: January 3, 1990

RE: Proposed Revisions to the Seattle Energy Code

Attached for your review in preparation for submittal to City Council is the proposed readoption of the Seattle Energy Code. This proposal was developed jointly by this Department and City Light.

Kermit Robinson of our Code Development and Coordination staff has spoken with Pat Schneider about this proposal.

The proposal is in the two ordinance format with the first ordinance adopting the model code by reference and the second adopting the local amendments to the ordinance. The ordinances are also prepared in the repeal and adoption style.

If you have any questions regarding the proposal, please contact John Hogan, project manager for the proposal at 386-9145 or Kermit at 386-9146.

Seattle
Department of Construction and Land Use

Dennis J. McLerran, Director
Norman B. Rice, Mayor

M E M O R A N D U M

TO: Mayor Norman B. Rice
via Andrew Lofton, OMB

FROM: Dennis J. McLerran, Director, Department of Construction and Land Use
Randall W. Hardy, Superintendent, Seattle City Light

DATE: December 26, 1990

SUBJECT: Proposed Update of the Non-residential Energy Code

SUMMARY

With this memorandum we are transmitting to you our proposal for revisions to the energy code for non-residential buildings. The proposal incorporates upgraded energy efficiency standards and other revisions based on the latest versions of national model codes and standards. Particular attention has been paid to the types of buildings and energy conservation measures appropriate for Seattle. The proposal is based on a recommendation of DCLU's Building Code Advisory Board (BCAB).

The proposal is based on newly updated versions of several regional and national standards, as modified by an extensive review by City staff and subcommittees of the BCAB energy committee. Major features of the proposal include:

* Elimination of the modeling requirement for major projects and reduction of the additional stringency required of major projects from 10% to about 1%.

* Extension of insulation requirements to all heated spaces.

* Simplified prescriptive approaches for building envelope and fan power requirements.

* Higher minimum efficiencies for heating and cooling equipment.

* Higher-efficiency lighting for some uses.

* Increase in stringency over current (1986) Seattle Energy Code.

The proposal is less stringent than the updated regional and national standards in lighting requirements and in warehouse insulation.

We believe that this proposal provides a good balance between Seattle's needs for energy conservation, in the context of renewed regional electric power deficits, fuel price instability, and global warming concerns, and the building community's legitimate request that codes be practical and be based on proven technologies.

Background.

The first steps toward this proposal originated in late 1987, in response to concerns raised by the building community that the Major Projects Requirement (MPR) of the current Seattle code was too complicated. (Major Projects are commercial buildings over 50,000 square feet; the MPR requires computer modeling of major projects and an additional 10% reduction in energy use below ordinary Seattle code standards.) As a first step to deal with this concern, DCLU published a Director's Rule offering a simple set of measures as an alternative to the major project computer modeling requirement. This set of measures was based on the most typical ones selected by designers in earlier major projects.

These prescriptive alternatives were intended to simplify code administration for major projects until a more comprehensive update of the commercial energy code could be proposed and adopted.

The commercial energy code update process began in mid-1989 in an environment of change in building standards and regional and local energy needs. Since adoption of the first Seattle Energy Code in 1980, Seattle's energy codes have been based on two national standards developed by ASHRAE. ASHRAE/IES Standard 90 defines criteria for energy-efficient design. The lighting criteria in Standard 90 were developed by the Illuminating Engineering Society (IES). ASHRAE Standard 62 defines criteria for acceptable ventilation. In 1989, new revisions of these standards had just received national approval. The Federal Department of Energy (DoE) also released a new standard for the design of new federal buildings which was similar to ASHRAE/IES 90.1-1989 but was somewhat more stringent for lighting.

In addition, the Northwest Power Planning Council (NPPC), the agency designated by Federal law to oversee electric energy resource planning in the region, had just updated its commercial Model Conservation Standard (MCS). The new commercial MCS is based on the updated ASHRAE/IES 90.1-1989 standard except for lighting allowances, where the DoE standard was used.

The new ASHRAE/IES and DoE standards are more stringent overall than current codes and standards, but the exact amount is hard to determine. In several important cases the fundamental form of an efficiency criterion was changed--for building envelope insulation and glazing, for example, or for ventilating fan power limits. The resultant new standards are more stringent than the older versions in most areas but are less stringent in

some. Based on computer modeling of typical prototype buildings, the ASHRAE/IES and DoE standard appears to be about 10% more stringent than the current Seattle Energy Code.

The Bonneville Power Administration recently released its 1990 Resource Program and associated planning studies. Based on these studies, Bonneville concluded that the regional electric power surplus is over, and that acquisition of both generation and conservation resources should begin anew. Bonneville's need to make resource expenditures in the region in the range of $200 million annually to meet projected load growth reinforces Seattle's concern that new buildings be constructed as efficiently as feasible.

In addition, Bonneville is studying potentially serious limitations in transmission capacity to Seattle and the Puget Sound region. Conservation investments could also offset the need for additional generation or transmission to avoid blackouts in the Puget Sound area.

Code Review.

The public review draft of the commercial code update issued by DCLU in September 1989 was based on the ASHRAE/IES and DoE standards as incorporated into the new commercial MCS. To review the proposed changes to the Seattle Energy Code, the Building Code Advisory Board established an energy committee and several subcommittees on envelope, lighting, and HVAC (heating, ventilating, and air-conditioning) equipment. The subcommittees thoroughly reviewed the draft, accepting many of the changes from current code and suggesting modifications to the draft in other areas. Those sections of the code which were extensively revised to reflect conceptual changes made by ASHRAE were reviewed particularly carefully. The BCAB adopted recommendations on the code update in early 1990.

Unfortunately, an analysis of the energy savings secured by the code was not available until after BCAB had made its recommendation. When the energy savings analysis was completed it raised concerns. Our prototype analyses of the office and retail sector showed no significant increase in stringency.

An increase in overall code stringency should be feasible because of known improvements in building technologies since our last code update in 1986. The importance of energy conservation has increased during that period. A growing awareness of global warming and of the disruptions possible in the supply and price of fuels, are examples of factors which have heightened conservation's importance. Staff therefore asked the BCAB to reconsider their code recommendation in the light of the lower-than-expected energy savings results. The BCAB subcommittees met several more times and made recommendations which both Departments support.

Comparison with ASHRAE/IES and DoE.

Our proposal stops short of the ASHRAE/IES and DoE requirements in a few significant areas:

* Retail lighting allowances, particularly in spaces less than 20,000 square feet, are higher than either the new IES standard (incorporated in ASHRAE/IES 90.1) or in the DoE standard.

* The DoE standard has lower lighting power allowances for almost all occupancies than the Seattle proposal.

* Warehouse insulation limits are less stringent than the ASHRAE/IES and DoE levels, although the warehouse requirements are substantially more stringent than in previous codes.

Comparison with Washington State Energy Code.

Compared with the current Washington State Energy Code (WSEC) for non-residential buildings, the 1986 Seattle Energy Code had similar requirements for small buildings and was 10% more stringent for major projects. This proposal complies with State law which requires that all non-residential energy codes be at least as stringent as the WSEC.

State Environmental Policy Act

A declaration of non-significance was issued for the proposal in October 1990. No appeals were submitted.

Format of the Proposed Code.

The format of the proposed code matches the proposed numbering for the Washington State Energy Code. The specific language of the code requirements is based on the current national Model Energy Code. The concepts used in the model code and in the proposed Seattle code are principally derived from the most recent update of Standard 90.1 of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and the Illuminating Engineers Society (IES).

In our proposed code, language from the Model Code which is not used in the proposed Seattle code is presented and stricken out. The stricken sections therefore do not necessarily represent all the changes from the current Seattle code. All notable changes from the current Seattle code are discussed in the attached section-by-section summary.

This proposal revises only those sections of the Seattle Energy Code (and related codes) which apply to non-residential buildings. Local government authority to adopt new residential energy code standards was preempted by new state legislation enacted in the 1990 session. The legislation also directs the State Building Code Council to upgrade the residential provisions of the State Energy Code; the code language embodying these changes was approved on November 9, 1990. Local governments are required to enforce the new language no later than July 1, 1991. When the new residential language has been incorporated into the Seattle Energy Code format it will be separately forwarded by DCLU.

Code Implementation.

Code implementation will require training and other tasks to account for the new code requirements. A summary of significant changes from the current energy code and a cost report are also attached. While some costs will be incurred to change to the new code, no increase in staff appears to be required.

We recommend an implementation date two months from final approval.

This code proposal represents the contributions of many in our community and in the region. We appreciate and commend the many hours of time which has been given by members of BCAB and its subcommittees, and the assistance offered by the Bonneville Power Administration and the Northwest Power Planning Council on code issues.

We would be pleased to provide you with briefings or more information on our recommendation.

ESTIMATES OF COST IMPACTS OF 1990
AMENDMENTS TO THE SEATTLE ENERGY CODE
December 1990

The cost estimates which follow can be subdivided into two categories: one-time or first-year costs, and ongoing costs. One-time or first year costs include publishing the new code, training for staff and the public, revising director's rules, public information and forms and additional plan review and inspection time attributed to the learning curve expected when all codes change. Ongoing costs are those over and above the current code which are expected to continue.

There are projected one-time or first-year costs in items 1, 2, 3, 5, 6, 7, 10a, 10e and 11. Ongoing costs are included in items 10d and 13c. Staff time is converted to cost at the rate of $71/hour. The overall estimate is for $56,000 in one-time or first-year costs and no net increase in ongoing costs (increases offset by benefits). The Bonneville Power Administration is projected to reimburse Seattle for $26,000 (items 1, 3, and 6), so the net cost to the City would be $30,000. A detailed breakdown follows the table.

Estimated Cost Impacts of 1990 Code Amendments to the Seattle Energy Code

	Task	Hours	Costs
1.	Training		
	a. Prepare materials	24	$ 1704
	b. Give training	31	2201
	c. Receive training	66	4686
2.	Copying		
	a. Cost for Ordinance		173
3.	Publishing		
	a. Cost for Code pages		492
4.	Map changes		
	a. Cartographer's time		--
	b. New map copying costs		--
5.	Revise Director's Rules		
	a. New or revised rule(s)	80	5680
	b. Rescind rule(s)	4	284
	c. Process rule(s)	40	2840
6.	Public Information		
	a. New bulletin preparation	190	13490
	b. Copy costs		3200
	c. More Information for public (phones)		--
7.	New Forms		
	a. Develop forms	30	2130
	b. Copy forms		200

Task	Hours	Costs
8. Code Clarification Committees		
a. More problems to be resolved		--
9. Procedural Changes		
a. New or revised procedure(s)		--
b. Process procedure(s)		--
c. Create new admin. process		--
d. New plans routing		--
e. New fees		--
f. Additional time to process plans		--
10. Plan Review Time		
a. Vesting impact	5	355
b. New type of decision		--
c. Additional review		--
d. More complex rules	-57	-4047
e. Learning curve	183	12993
11. Automation		
a. New or revised screen(s) needed	54	5284
b. New codes		--
12. Enforcement		
a. Caseload increase		--
b. Effects on Municipal Court		--
13. Inspections Impacts		
a. New special inspections		--
b. More items to inspect		--
c. New type of inspection	58	4118
14. Records Management/Microfilm		
Will it require substantially more filing space?		--
15. New types of Permits		--
16. Space and equipment costs		
a. Space costs for new staff or equipment		--
b. Cost of new equipment		--
17. Total for amendment		
a. One-time or first-year costs[2]		
- Gross	707	55712
- BPA reimbursable (projected)	311	25763
- Net	396	29949
b. Ongoing costs/year[3]	1	71

[1] Costs are based on $71/hour of staff time.
[2] One-time or first-year costs include all costs except on going costs.
[3] Ongoing costs are from items 10d and 13c.

Notes on Line Item Cost Impacts Estimate for 1990 Seattle Energy Code

	Hours	Costs
1. Training		
a. Prepare materials		
Staff training: John Hogan/Terry Ross/Robby Liem	16	$ 1136
Public training: John Hogan/Terry Ross/Robby Liem	8	568
b. Give training		
Staff training: John Hogan/Terry Ross/Robby Liem	23	1633
Public training: John Hogan/Terry Ross/Robby Liem	8	568
c. Receive training		
Staff training (*most during regular staff meetings)		
Energy/mechanical section (4 staff x 15 hours)	60	4260
Building plans examiners (20 x 0.5 hours)*		
Intake staff (15 x 0.5 hours)*		
Electric plans examiners (2 x 1 hour)*		
Building inspectors (15 x 1 hr.)*		
Mechanical inspectors (3 x 2 hrs.)	6	426
Electrical inspectors (15 x 1 hr.)*		
Boiler inspectors (5 x 0.5 hrs.)*		
Code development and coordination (12 x 0.5 hrs)*		
City Light (20 x 1 hr)*		
23 hrs.		
Public training		
General (50 x 2 hrs.)		
AIA (20 x 2 hrs.)		
ASHRAE (40 x 2 hrs.)		
IES (30 x 2 hrs.)		
8 hrs.		
2. Copying		
Cost for ordinance		
150 ordinance pages x $0.035/page = $5.25/copy x 31		173
Distribution (in same order as for training above)		
(4) Liem, Chiu, Go, and Parast		
(5) Kinsman, Kimball, Pfeiffer, Siu and Wong		
(1) Blazina		
(1) Blackburn		
(1) Weller		
(1) Westman		
(2) Zempel		
(1) Gentry		
(4) Hogan, Robinson, Ross		
(4) Pool, Fiddler, Holt and Rekhi		
(6) Garcia, Gilbert, Hairston, Herzfeld and Lampe		
(1) Hansen		
(1) Bossart		
(1) Anton		

Task	Hours	Costs
3. Publishing		
Cost for code pages		
150 ordinance pages x 2/3 code		
pages/ordinance page x $0.04 = $4.00/copy		
x 123		
(111) All listed under staff training		
(6) DCLU Division Directors		
(6) Fire, Water, Health, Law, OMB and Mayor		492
4. Map Changes		
None required		
5. Revise Director's Rules		
a. New or revised rules		
Revised:		
3-87 Energy Consumption for Environmental Review	20	1420
40-88 Standard Design for Energy Analysis	20	1420
25-90 Additions, Alterations and Repairs	20	1420
New:		
?-91 Ventilation Effectiveness	20	1420
b. Rescind Rules		
45-88 Minimum Pipe Insulation	1	71
46-88 Energy-Efficiency for Boilers and Furnaces	1	71
6-89 Prescriptive Path for Major Projects	1	71
24-90 1990 State Energy Code Component Performance Revisions	1	71
c. Process Rules		
8 Rules x 5 hours/rule	40	2840
6. Public Information		
a. New bulletin preparation		
Revised:		
303A Common Single Family Code Items (7pp)	5	355
304 Prefab Steel Buildings (1 pg)	5	355
403 Glazing Test Values (64 pp)	50	3550
404 True Seven Day Programmable Thermostats (2pp)	5	355
405 Efficient Lighting Equipment (9pp)	10	710
406 Outdoor Air Quality and Ventilation (4pp)	5	355
407 Computer Guidelines: TRACE 500 (14 pp)	15	1065
408 Computer Guidelines: DOE-2 (15 pp)	15	1065
409 Computer Guidelines: ESAS (22 pp)	15	1065
410 Computer Guidelines: HAP (17 pp)	15	1065
	155 pp	
New		
4-- Motor Efficiency (5 pp)	10	710
Visual specialist time: 160 pagesx.25 hours/page	40	2840
b. Copy costs		
160 pages x $0.04/page x 500 copies		3200
c. More information for public (phones)		

Task	Hours	Costs
7. New Forms		
a. Develop forms		
Revised:		
Heating Load Calculation Form (4 pp)	10	710
Lighting Power Allowance Form (2 pp)	10	710
New:		
Cooling Load Calculation Form (4 pp)	10	710
b. Copy forms		
10 pages x $0.04/page x 500 copies		200
8. Code Clarification Committee		
More problems to be resolved		
Energy and mechanical code clarifications are discussed every week at normally scheduled one-hour meetings. The percent of time devoted to each code varies from meeting to meeting. For the first year, there will likely be more time devloted to energy code clarification and less to mechanical code. Building and electrical inspectors who usually don't attend may need to attend some meetings at first. No long-term increase.		
9. New Procedures		
None required.		
10. Plan Review Time		
a. Vesting impact		
50 projects x 6 min/project to check date of application	5	355
b. New type of decision		
None		
c. Additional review		
See More Complex Rules for ongoing costs and Learning Curve for first-year costs		
d. More complex rules (ongoing costs)		
Increases in the number of options for demonstrating compliance, increases in the number of exceptions, checking for heat recovery and integrated-part-load-value for mechanical equipment; offset by reductions in the use of component performance method, simplification of the fan system efficiency calculations and elimination of computer modeling requirement for major projects.		
New major projects (6/yr x -40 hrs)	-240	-17040
New small commercial (60 x 15 min/project)	15	1065

SECTION BY SECTION SUMMARY OF
PROPOSED REVISIONS TO THE SEATTLE ENERGY CODE
(WITH COMPANION CHANGES TO THE SEATTLE BUILDING CODE
AND THE SEATTLE MECHANICAL CODE)
December 1990

The following summary addresses notable changes only and provides a brief explanation.

Section	Subject	Comment
101.3.2.1	Additions	The language from Director's Rule (DR) 25-90 is included here. More specific guidelines are provided for calculating compliance for either the addition alone or for the addition plus existing building.
101.3.2.4	Alterations and Repairs	The language from DR 25-90 is substituted here. Compliance is allowed either with Chapter 4 or 5 or with the requirements here. For the building envelope, the requirements are based on the prescriptive approach in Table Nos. 5-1 and 5-2. For other than Group R occupancy, new glazing need not comply with the shading coefficient as long as it is equal or better than that of the other existing glazing.
107	Violations and Penalties	Completely revised to match Section 205 of the Seattle Building Code.
201.1	Definitions	Definitions are added or replaced for about 50 terms, mostly per ASHRAE/IES 90.1. Also references made to the Seattle Building and Mechanical Codes where possible to avoid conflicts.
202	Abbreviations, Acronyms, and Symbols	New section with more than 60 elements added per ASHRAE 90.1.
302.2.1	Indoor Design Temperature	Cooling temperature reduced to 75°F per ASHRAE 90.1

Section	Subject	Comment
303.1	Ventilation	Ventilation requirements deleted here, to be incorporated in the Seattle Building Code and Seattle Mechanical Code. See discussion below.
401.1	Systems Analysis	Major projects no longer required to use Chapter 4.
402.1	Energy Analysis	Major projects no longer required to show 10% energy-efficiency improvement. Reference is made to Chapter 9 for modeling assumptions. See discussion below.
402.4	Calculation	Modeling assumptions deleted here. New assumptions generally per ASHRAE 90.1 in Chapter 9.
502.1.1	Required Calculation Procedures	Calculation procedures are more explicitly stated per ASHRAE. Zone method or correction factors to be used for metal framing. Examples in Chapter 10 shall be used as the basis for all calculations. This intent here is for greater accuracy, more easily achieved and better consistency.
502.1.5	Glazing U-Values	For other than Group R occupancy, glazing U-value calculations to correspond with new area-weighted procedure for center-of-glass, edge-of-glass and frame components from 1989 ASHRAE Fundamentals Handbook.
502.2	Criteria for Group R Occupancy	1990 Washington State Energy Code amendments which have been enforced through Director's Rule 18-90 (and 24-90) are now incorporated in the text.
502.3	Criteria for All Other Occupancies	Standards revised to match ASHRAE 90.1, cooling loads now part of the criteria. Primary change is in treatment of glazing. Credit given for thermal mass. Exception allowed for skylights with daylighting controls. Separate

Section	Subject	Comment
502.3 (cont.)		criteria for semi-heated buildings (i.e., warehouses) which requires improvement over current situation, but does not require full insulation as ASHRAE 90.1 does.
502.3.2	Prescriptive Approach	A range of glazing percentages (20-70% max.) are listed as prescriptive options. The higher glazing percents require double-glazing with a low-emissivity coating or better in a frame with a thermal break and with the glazing to have a low shading coefficient.
502.4	Air Leakage for All Buildings	For other than Group R Occupancy, revised for consistency with ASHRAE 90.1.
503.3.1	Separate Air Distribution Systems	Separate air distribution systems required for areas with special process temperature or humidity requirements per ASHRAE.
503.3.2	Simultaneous Heating and Cooling Zone Controls	Exceptions have been modified. VAV systems required to have fan-powered terminal units and to be capable of reducing the flow to the minimum for outside air before reheating takes place. Constant volume systems and areas with specified humidities required to have heat recovery if system and outdoor air percent are large.
503.3.3	Supply Temperature Reset Controls	Supply temperature reset controls required for both air and hydronic systems per ASHRAE.
503.3.4	Heat Recovery Systems	Heat recovery required for systems over 5000 cfm if outdoor air supply is 75% of the total air, per a combination of DR 6-89 and ASHRAE 90.1 systems analysis prototype HVAC system assumptions.

Section	Subject	Comment
503.4.1	Minimum HVAC Equipment Efficiencies	Minimum HVAC efficiencies revised per a condensation of ASHRAE 90.1 and the National Appliance Energy Conservation Act, includes both 1989 and 1992 efficiency tiers, and integrated part-load values.
503.5.1	Fan System Design Criteria	Transport efficiency now determined in watts/cfm per ASHRAE. Value ranges from 0.8 for constant volume systems to 1.25 for VAV systems. Calculation of space sensible cooling load is no longer required. Systems with 10 hp or less are exempted. Variable speed capability required for motors 15 hp and larger per ASHRAE systems analysis prototype HVAC system assumptions. Exemptions allowed for systems with inlet vane fans and 0.90 watts/cfm.
503.7.1	Economizer Controls	Either an air or water economizer system is required for most buildings per ASHRAE. Economizer systems shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the load. Exemption for heating systems with a partial economizer in buildings with breakeven temperature of 40°F.
503.8.3.4	Off-hour Controls	Per ASHRAE 90, areas with non-simultaneous use for over 750 hours/year required to have isolation devices to independently control each zone.
503.9	Duct Insulation	Ducts required to be insulated when difference between temperature in duct and surrounding air is more than 15 degrees per ASHRAE 90.
503.11	Pipe Insulation	Revised per ASHRAE 90.

Section	Subject	Comment
504.2.1	Water Heater Performance Efficiency	Standards updated to match National Appliance Energy Conservation Act.
504.2.3	Combination Water Heating/ Space Heating Equipment	Criteria revised per ASHRAE 90 as to when these systems are acceptable. They must comply with both space heating and water heating efficiency requirements.
504.7.2	Pipe Insulation	Pipe insulation now required for first 8 feet of non-circulating service water heating systems per ASHRAE 90.
504.8.	Conservation of Hot Water	Both flow rate and controls revised to match SHB 1397 and ASHRAE 90.
505.2.1	Electrical Distribution System	Requirements not added for submetering (presumed included in City Light requirements). Requirements not included for transformer loss calculation estimates.
505.2.2	Electrical Motors	Requirements added for minimum motor efficiency as ASHRAE/IES 90.1 has now done. Requirements cited here for energy-efficient motors as defined by NEMA.
505.3.1	Lighting Budget Development	No trade-offs of exterior lighting to gain interior lighting. Credits for automatic lighting controls deleted.
505.3.2	Building Interiors	Two compliance variations now allowed: gross floor area and usable floor area. Space-by-space IES 90.1 method not included. Separate categories established for libraries, schools, mall concourse and food service. Current format retained with only one unit lighting power allowance (ULPA) for each occupancy description, except that retail has three ULPAs. ULPA is higher for small

Section	Subject	Comment
505.3.2 (Cont.)		retail spaces, lower for schools, workshops, office-type spaces (major projects with special requirements) and warehouses. Other values similar. Threshold for height bonus generally lowered. Special merchandise bonus added for retail spaces over 20,000 square feet. ULPA's generally comply with IES 90.1, except for retail. Most ULPA's do not comply with the Commercial Model Conservation Standards.
505.3.3	Exceptions to Interior and Exterior Criteria	Exceptions completely revised and expanded per IES 90.1 and BCAB.
505.3.4	Building Exteriors	Exterior lighting power allowances comply with IES 90.1, lower for parking garages, higher for facade, surface parking and circulation.
505.4	Lighting Switching	Lighting switching requirements almost completely revised per IES 90.1. Daylight zone requirements retained but modified so as to allow single-level switching.
701.1	Standards	List of reference standards updated.
901 and 902	Assumptions to be used with Chapter 4 Systems Analysis	The assumptions listed here would replace those currently in Chapter 4 and in Director's Rule 40-88. The material is drawn primarily from Section 13 of ASHRAE/IES Standard 90.1. Two options are now allowed for the base case building: the prototype and the reference building. The key difference is that prototype building would have the HVAC system type listed here while the reference building would use the same HVAC system type as the proposed design.

Section	Subject	Comment
1001 to 1009	Required Assumptions for U-Value Calculations	This chapter corresponds with Appendix C of the Model Energy Code but is totally revised paralleling the Washington State Energy Code and is new to the Seattle Energy Code. It provides total assembly U-values for a variety of roofs, walls, floors, and doors. The residential assemblies are taken from the BPA reference manual for the Super Good Cents program. The commercial assemblies and correction factors are based on ASHRAE Standard 90.1. By providing this reference with the code and requiring its use, the preparation and review of calculations ought to be easier and more consistent.

SEATTLE BUILDING CODE REVISIONS

Section	Subject	Comment
416	Definitions	Add definition of "occupied zone" per ASHRAE Standard 62-1989.
423	Definitions	Add definition of "ventilation effectiveness" per ASHRAE Standard 62-1989.
514	Outdoor Air Requirements for Ventilation	Add a new section and new Table No. 5-F to incorporate outdoor air requirements from ASHRAE Standard 62-1989. This standard was recently adopted by the Washington State Building Code Council. Current outdoor air requirements are based on the 1973 version of this standard and do not reflect current knowledge about indoor air quality.
605	Ventilation	Change reference to Section 514.
705	Ventilation	Change reference to Section 514.
905	Ventilation	Change reference to Section 514.

SEATTLE MECHANICAL CODE REVISIONS

Section	Subject	Comment
403	Definitions	Delete "appliance, solid fuel burning".
408	Definitions	Revise "fireplace" per WSEC, delete "fireplace insert" and "fireplace, zero clearance".
421	Definitions	Delete "solid fuel", add "solid fuel burning appliance" per WSEC.
425	Definitions	Add "wood stove" per WSEC.
514	Fireplaces and Solid Fuel Burning Appliances	Add a new section with the requirements from Section 411 (h) and (i) of the WSEC.
601	Combustion Air Supply	Add references to Section 514, delete conflicting language.
602	Dampers	Add reference to Section 514.

JH:jk
901016
I:90-ENERGY.CPT/prop.1 - prop.9

ADDENDUM TO
SECTION BY SECTION SUMMARY OF
PROPOSED REVISIONS TO THE SEATTLE ENERGY CODE
(WITH COMPANION CHANGES TO THE SEATTLE BUILDING CODE
AND THE SEATTLE MECHANICAL CODE)
18 March 1991

The following summary is a supplement to the December 1990 summary. This summary addresses notable changes only and provides a brief explanation. Some material here may supersede that in the previous summary. These requirements are mandated by State law. For the actual proposal, refer to the ordinance.

Section	Subject	Comment
101.3.2.1	Additions	Compliance allowed to be calculated with existing building if addition is less than 750 sf per 1991 Washington State Energy Code (WSEC).
101.3.2.3	Change of Occupancy or Use	New stringent requirements for change of occupancy or use to comply with new construction requirements per 1991 WSEC.
101.3.2.5	Building Envelope Alterations	Roof insulation required if roofing is removed to the level of the sheathing per 1991 WSEC.
201.1	Definitions	Definitions added or revised per 1991 WSEC.
402.6	Systems Analysis for Group R Occupancy	New section with detailed modeling assumptions provided for annual energy analysis for residential-type spaces per 1991 WSEC.
502.1.4	Insulation Installation	More detailed specifications - attic hatches to be insulated, wall insulation to be face-stapled, floor insulation to be in contact with floor, radiant slabs to have R-10 insulation under entire slab per 1991 WSEC.

Section	Subject	Comment
502.1.5	Glazing U-Values	Testing methods updated, some new sizes listed, transition periods specified per 1991 WSEC.
502.2	Criteria for Group R Occupancy	Multiple prescriptive path compliance options offered for 10-30% glazing area range (current code has only one prescriptive path), base case for Target UA tradeoff compliance option has 0.65 glazing U-value for gas/oil/heat pump and 0.40 glazing U-value and insulated doors and R-30 floor insulation for electric heat per 1991 WSEC.
502.4	Air Leakage	Lighting fixtures recessed in the building envelope to meet air leakage requirements per 1991 WSEC.
503.4.1	Minimum HVAC	Furnace efficiency raised to 78% AFUE, heat pump HSPF raised to 6.6 for single package and 6.8 for split systems per 1991 WSEC.
503.8.3.5	Heat Pump Controls	Programmable thermostats required for heat pumps per 1991 WSEC.
503.9	Duct Insulation	R-8 insulation for ducts on exterior or in unconditioned spaces for Group R Occupancy per 1991 WSEC.
503.11	Pipe Insulation	R-3 insulation for all pipes, both hot and cold water, which are located outside of the conditioned space per 1991 WSEC.
801	Computer Software	Suggested software for Group R Occupancy annual energy analysis per 1991 WSEC.

ACCOMPANYING SEATTLE MECHANICAL CODE CHANGES
(Supersedes December 1990 Summary)

Section	Subject	Comment
403-426	Definitions	Add approximately 30 definitions per 1991 Washington State Ventilation and Indoor Air Quality Code (WSVIAQC) and 2 per ASHRAE Standard 62-1989.
601	Combustion Air Supply	Add references to Chapter 10.1 and delete conflicting language.
602	Location	Add reference to Chapter 10.1.
604	Location	Add reference to Chapter 10.1.
10.101-10.106	Ventilation and Indoor Air Quality	Add a new Chapter 10.1 which specifies mechanical ventilation for all Group R Occupancy and adopts the 1989 version of ASHRAE Std. 62 for all other occupancies per 1991 WSVIAQC (with slight revisions to text for Other than Group R Occupancy per DCLU Building Code Advisory Board recommendations).

ACCOMPANYING SEATTLE BUILDING CODE CHANGES
(Supersedes December 1990 Summary)

Section	Subject	Comment
605,705, and 905	Ventilation	Change reference to Chapter 10.1 of the Seattle Mechanical Code.
1205	Ventilation	Require compliance with mechanical ventilation requirements in Chapter 10.1 of Seattle Mechanical Code.
1720	Radon	Add requirements for minimum radon resistive construction per 1991 WSVIAQC.
1721	Formaldehyde	Add limitations on formaldehyde in building materials per 1991 WSVIAQC.

Office of the Mayor
City of Seattle

Norman B. Rice, Mayor

April 12, 1991

The Honorable Paul Kraabel, President
Seattle City Council
City of Seattle
01-11-01

Dear Councilmember Kraabel:

I am pleased to send to you a proposed comprehensive update of the Seattle Energy Code. This is the first major rewrite of the City's energy-related code provisions since 1986. I see these initiatives as a good beginning for a very ambitious goal: to make Seattle the most energy-efficient city in the nation. Every citizen today will benefit from reduced energy bills for heating, cooling and lighting -- and the benefits will continue for decades. These improvements will also help the nation and the world meet ever more pressing environmental problems.

The new code provisions will upgrade energy efficiency requirements for most of the important energy-using components of new buildings, will bring the Seattle code into conformance with national model codes and standards, and will simplify code administration. Taken together with new conservation initiatives, the new code complies with the updated requirements of the Northwest Power Planning Council's Model Conservation Standards. The code also brings the Seattle residential energy code into compliance with new provisions of state law. The code provisions were developed by the Seattle Department of Construction and Land Use, working closely with the Building Code Advisory Board, Seattle City Light, the Bonneville Power Administration, and the Northwest Power Planning Council.

This proposed code is only one of several important new energy conservation initiatives, for both new and existing buildings, underway in Seattle today. Seattle City Light has brought forward several new programs in the last 18 months, usually in cooperation with Bonneville, the federal regional electricity supplier. In 1989 the Lighting Design Lab was opened to provide advocacy and design service for efficient and innovative lighting designs. In addition, Seattle City Light has recently added dollar incentives to its Energy Smart Design program for new commercial buildings.

These incentives will provide about half of the additional cost of electricity conservation measures which go beyond the requirements of the energy code. More than $3 million annually is budgeted for investment in the energy future of new Seattle buildings through this program -- an investment which will also boost the local economy. More new initiatives are in planning. We hope soon to be able to expand this program to provide an additional $3 million per year for a comprehensive incentive program to conserve electricity in existing commercial buildings, and to upgrade the lighting in multifamily residential buildings.

The new code provides a crucial underpinning for incentive programs, by assuring ratepayers that the additional features represent a real improvement on the status quo. The code also qualifies builders of new residences to receive payments to cover their extra costs in the early years of the new code.

I want to thank the citizens and members of the building community who have helped us develop the provisions of this new energy code proposal.

Sincerely,

Norman B. Rice

cc: Randall W. Hardy, Superintendent, Seattle City Light
Andrew Lofton, Director, Office of Management and Budget
Dennis McLerran, Director, Department of Construction and Land Use
Tom Tierney,Deputy Chief of Staff, Mayor's Office
Lawrence G. Gunn, Director, Energy Management Services Division, Seattle City Light

SEATTLE CITY ATTORNEY
MARK H. SIDRAN

MEMORANDUM

TO: Andrew J. Lofton, Budget Director

FROM: Margaret Klockars, Assistant City Attorney

RE: Review of Proposed Energy Code Amendments

DATE: April 3, 1991

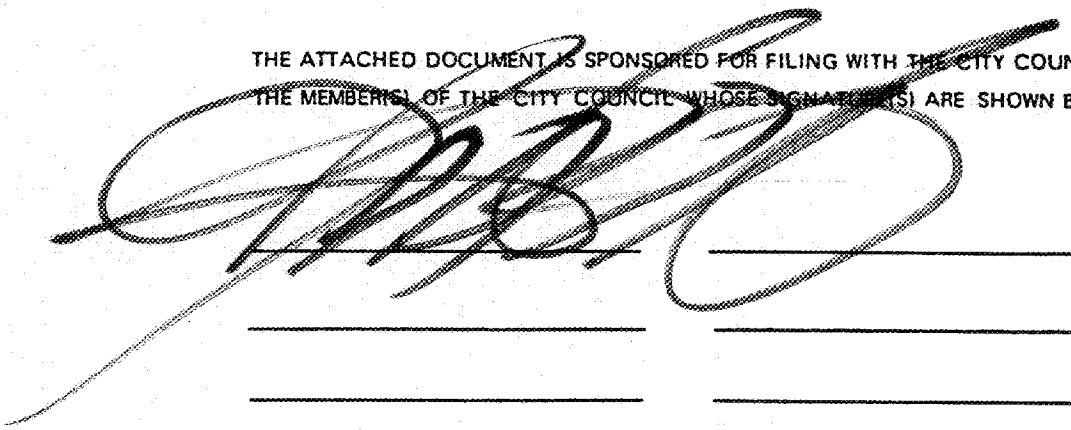
We have completed review of the proposed Energy Code amendments. Because of the technical nature of the subject matter of this legislation, the Law Department's review and approval is limited to form.

MK/ks
Energy.mem

TIME AND DATE STAMP

SPONSORSHIP

THE ATTACHED DOCUMENT IS SPONSORED FOR FILING WITH THE CITY COUNCIL BY THE MEMBER(S) OF THE CITY COUNCIL WHOSE SIGNATURE(S) ARE SHOWN BELOW:



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PRESIDENT'S SIGNATURE

C.S. 20.28

STATE OF WASHINGTON - KING COUNTY

5240
City of Seattle

—ss.

No.

Affidavit of Publication

The undersigned, on oath states that he is an authorized representative of The Daily Journal of Commerce, a daily newspaper, which newspaper is a legal newspaper of general circulation and it is now and has been for more than six months prior to the date of publication hereinafter referred to, published in the English language continuously as a daily newspaper in Seattle, King County, Washington, and it is now and during all of said time was printed in an office maintained at the aforesaid place of publication of this newspaper. The Daily Journal of Commerce was on the 12th day of June, 1941, approved as a legal newspaper by the Superior Court of King County.

The notice in the exact form annexed, was published in regular issues of The Daily Journal of Commerce, which was regularly distributed to its subscribers during the below stated period. The annexed notice, a

ORDINANCE 115641

was published on

05/29/91

The amount of the fee charged for the foregoing publication is the sum of $, which amount has been paid in full.

K. Kells

Subscribed and sworn to before me on

05/29/91

Jennifer A. Nicholson

Notary Public for the State of Washington,
residing in Seattle

1

City of Seattle Ordinances

City of Seattle

ORDINANCE 115641

AN ORDINANCE relating to energy-efficiency, energy conservation, indoor air quality and ventilation in building construction; amending Section 22.700.010 Seattle Municipal Code ("SMC") to adopt by reference the 1989 Model Energy Code; amending Sections 101, 103, 104, 105, 106, 201, 302, 303, 401, 402, 502, 503, 504, and 505 and Chapters 4, 5 and 7, repealing Section 403, Chapter 6, and the Appendix, adding new Sections 107, 108, 109, 202 and new Chapters 8, 9 and 10 to the Model Energy Code to incorporate the minimum requirements of the 1991 Washington State Energy Code (Chapter 51-11 WAC) and the Washington State Water Conservation Performance Standards (SHB 1397 and WAC 51-18), and to revise the requirements for Other than Group R Occupancy; amending Sections 403, 404, 405, 406, 408, 410, 415, 417, 420, 421, 422, 423, 424, 425, 426, 601, 602, and 604 of the Seattle Mechanical Code and adding a new Chapter 10.1 to the Seattle Mechanical Code to incorporate the 1991 Washington State Ventilation and Indoor Air Quality Code (Chapter 51-13 WAC); amending Sections 605, 705, 905 and 1205 of the Seattle Building Code and adding new Sections 1720 and 1721 to the Seattle Building Code to correct cross-references to the Seattle Mechanical Code and to incorporate provisions of the 1991 Washington State Ventilation and Indoor Air Quality Code; and amending SMC Sections 22.100.010 and 22.400.010.

BE IT ORDAINED BY THE CITY OF SEATTLE AS FOLLOWS:

Section 1. As of July 1, 1991, Section 22.700.010, SMC, as last amended by Ordinance 113059, is further amended as follows:

22.700.010 Adoption of the Model Energy Code and State and local amendments.

The Model Energy Code ((~~1986~~)) 1989 Edition, published by the Council of American Building Officials, and the amendments thereto adopted by Ordinance ((~~113059~~)) ________ incorporating the Seattle Amendments ((and)), the Washington State residential requirements of RCW 19.27A.020 ((~~(1)(a) and (b)~~)) (4) and the Washington State Energy Code and the Washington State Water Conservation Performance Standards (RCW 19.27.170 and WAC 51-18), copies of which are filed with the City Comptroller in C.F. ((~~295163~~)) ________ are hereby adopted and by this reference made a part of this subtitle and shall constitute the official Energy Code of the City.

Section 2. As of July 1, 1991, Section 101 of the 1989 Model Energy Code is amended as follows:

CHAPTER 1
ADMINISTRATION AND ENFORCEMENT

SECTION 101 - SCOPE AND GENERAL REQUIREMENTS

101.1 Title: This code shall be known as the ((~~Model~~)) Seattle Energy Code, and may be cited as such. It is referred to herein as "this code."

101.2 Intent: The purpose of this code is to provide minimum standards for new or altered buildings and structures or portions thereof to achieve efficient use of energy.

The provisions of this code shall regulate the design of building envelopes for adequate thermal resistance and low air leakage and the design and selection of mechanical, electrical, service water-heating and illumination systems and equipment which will enable effective use of energy in new building construction and existing buildings to the extent that they are regulated by Section 101.3.2 consistent with a healthful environment.

It is intended that these provisions provide flexibility to permit the use of innovative approaches and techniques to achieve effective utilization of energy. These provisions are structured to permit compliance with the intent of this code by ((~~any one~~)) either of the following ((~~three~~)) two paths of design:

- A systems approach for the entire building and its energy-using sub-systems which may utilize nondepletable sources, Chapter 4.
- A prescriptive/component performance approach for various building elements and mechanical systems and components, Chapter 5.

((~~A Specified acceptable practice, Chapter 6.~~))

Compliance with ((any one)) either of the ...
intent of this ...

Group R Occupancy shall be required to comply with all of the provisions of this code if either new or increased heating or cooling is provided.

5. All Occupancies, which are converted from a Group R Occupancy or an Other than Group R Occupancy or use, to a new Other than Group R Occupancy or use shall comply with the lighting standards set forth in this code unless the existing lighting is not altered.

101.3.2.4 Alterations and repairs: All alterations and repairs to buildings or portions thereof originally constructed subject to the requirements of this code shall conform to the provisions of this code without exception. For all other existing buildings, initial tenant alterations shall comply with the new construction requirements of this code. Other alterations and repairs may be made to existing buildings and moved buildings without making the entire building comply with all of the requirements of this code for new buildings, provided the following requirements of Subsections 101.3.2.5, 101.3.2.6, 101.3.2.7 and 101.3.2.8 are met:

101.3.2.5 Building envelope: The result of the alterations or repairs both:

1. Improves the energy efficiency of the building, and
2. Complies with (a) the nominal R-values and glazing requirements of the reference case in Table Nos. 6-1 to 6-6 or 5-2, or (b) the overall average thermal transmittance values of the elements of the exterior building envelope in Table No. 5-1 or 5-2 of Chapter 5.

Exceptions

1. Untested storm windows may be installed over existing glazing for an assumed U-value of 0.90, however, where glass and sash are being replaced in Group R Occupancy, glazing with a maximum area weighted average U-value of 0.40 shall be installed where there is an electric resistance space heating system and glazing with a maximum U-value of 0.65 shall be installed where there is any other space heating system.

2. Where the structural elements of the altered portions of roof/ceiling, wall or floor are not being replaced, these elements shall be deemed to comply with this code if all existing framing cavities which are exposed during construction are filled to the full depth with batt insulation or insulation having an equivalent nominal R value while, for roof/ceilings, maintaining the required space for ventilation. Existing walls and floors without framing cavities need not be insulated. Existing roofs shall be insulated to the requirements of this code if:

   (a) The roof is uninsulated or insulation is removed to the level of the sheathing, or

   (b) All insulation in the roof/ceiling was previously installed exterior to the sheathing or nonexistent.

3. For other than Group R occupancy, new glazing need not comply with the shading coefficient as long as it is equal to or lower than that of the other existing glazing. It shall not be higher than the shading coefficient of other existing glazing unless the glazing area, U-value and shading coefficient all comply with one of the packages listed in Table No. 5-2.

101.3.2.6 Building mechanical systems: Those systems or parts of systems which are altered or replaced shall comply with Section 503.

101.3.2.7 Service water heating: Those systems or parts of systems which are altered or replaced shall comply with Section 504.

101.3.2.8 Lighting: Those parts of systems which are altered or replaced in buildings initially constructed subject to the requirements of this code shall comply with Section 505. Other remodels or replacements of lighting systems which are part of a substantial remodel shall comply with Section 505. For any other remodels, the installed watts per square foot shall be maintained or reduced. Remodeling of any sized area, with or without putting in a new ceiling grid or suspension system, when reusing existing fixtures and/or adding new ones, shall not require compliance with the lighting power budget as long as the installed lighting wattage is maintained or reduced. Remodeling of an entire floor or entire tenant space that includes a new lighting system, with or without a new ceiling grid or suspension system, does require compliance with the lighting power budget of Section 505. Compliance with switching requirements of Section 505 is only required when new wiring is being ...
adding fixtures ...