The U.S. Department of Energy presents

Inspecting for the Commercial Provisions of the IECC

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Inspecting for the Commercial Provisions of the IECC Workbook

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Foreword

The purpose of this video and workbook training program is to acquaint you with the code provisions involving inspection of the commercial provisions of the 2000 *International Energy Conservation Code®* (IECC®).

The video and workbook will lead you through an inspection for the energy features required in the 2000 IECC and demonstrate how this additional inspection will fit into your typical inspection process. Inspections for the following building systems will be highlighted in the video and workbook:

- Building Envelope
- Mechanical System
- Service Water Heating System
- Lighting System

This workbook may be reviewed either before or after viewing a particular segment of the accompanying video training tape. The workbook may be used as a resource guide in your inspections, plan review, or project design.

Objectives

The materials in this reference manual are designed to assist you in determining acceptable or unacceptable installations for energy conservation features as they relate to the 2000 IECC. After completing the video and workbook training program you will be able to:

1. Inspect for the required insulation levels, glazing *U*-factor and solar heat gain coefficient (SHGC) requirements and air sealing provisions to meet the intent of the IECC.
2. Inspect for the heating, ventilating, and air conditioning (HVAC) requirements and verify that the ducts have been sealed and insulated properly and that the correct control devices have been installed.
3. Verify that the installed lighting and control devices for interior and exterior lighting meet the intent of the IECC.

Suggestions

To benefit fully from the video and workbook training program, it is recommended that you have the following:

1. The ability to read and understand basic construction drawings
2. A basic knowledge of construction methods and materials
3. A copy of the *International Energy Conservation Code*

Several tables, referenced in both the video and workbook, appear in the text of the IECC. The workbook also has a listing of the applicable code provisions for each item that is discussed, making the IECC a valuable part of your code book library.

Review questions will be found at the end of this workbook. After viewing the video you should answer these questions.

You will need a pencil or pen in order to complete the questions. Please allow approximately 3 hours to complete this video training tape.

Once you have viewed this video training tape and receive a passing score upon completion of the accompanying examination, you will be eligible for 0.3 Continuing Education Units (CEUs). Members of the American Institute of Architects (AIA) will receive 3 Health, Safety and Welfare (HSW) Learning Units (LUs). To receive this credit, you must complete the examination. Instructions for completing the exam and submitting your response to ICBO may be found in the examination section of this workbook.

Glossary

The following terms should be reviewed before viewing the video and reading the workbook. This will help maximize the benefit of using the training tool. The terms that are presented are common to commercial energy code inspection and design.

Above-grade walls – Those walls (Section 802.2.1) on the exterior of the building and completely above grade or the above-grade portion of a basement or first-story wall that is more than 15 percent above grade.

Annual fuel utilization efficiency (AFUE) – The ratio of annual output energy to annual input energy, which includes any nonheating season pilot input loss and for gas or oil-fired furnaces or boilers does not include electrical energy.

Approved – Approved by the code official or other authority having jurisdiction as the result of investigation and tests conducted by said official or authority, or by reason of accepted principles or tests by nationally recognized organizations.

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").

Below-grade walls – Basement or first-story walls (Section 802.2.8) associated with the exterior of the building that are at least 85 percent below grade.

Btu – Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound (0.454 kg) of water 1°F (0.56°C), (1 Btu = 1,055 J).

Building envelope – The elements of a building that enclose conditioned spaces through which thermal energy is capable of being transferred to or from the exterior or to or from spaces exempted by the provisions of Section 101.4.1

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 Sections 503 and 803).

Commercial building – All buildings over three stories in height above grade, or buildings other than residential buildings that are three stories or less in height above grade.

Condenser – A heat exchanger designed to liquefy refrigerant vapor by removal of heat.

Condensing unit – A specific refrigerating machine combination for a given refrigerant, consisting of one or more power-driven compressors, condensers, liquid receivers (when required), and the regularly furnished accessories.

Cooled space – Space within a building that is provided with a positive cooling supply (see "Positive cooling supply").

Crawlspace wall – The opaque portion of a wall that encloses a crawl space and is partially or totally below grade.

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

Degree day, Cooling – A unit, based on temperature difference and time, used in estimating cooling energy consumption and specifying nominal cooling load of a building in summer. For any one day, when the mean temperature is more than 65°F (18°C), there are as many degree days as there are degrees Fahrenheit (Celsius) difference in temperature between the mean temperature for the day and 65°F (18°C). 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 heating energy consumption and specifying nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65°F (18°C), there are as many degree days as there are degrees Fahrenheit (Celsius) difference in temperature between the mean temperature for the day and 65°F (18°C). Annual heating degree days (HDD) are the sum of the degree days over a calendar year.

Duct – A tube or conduit used for conveying air. The air passages of self-contained systems are not to be construed as air ducts.

Duct system – A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans, and accessory air-handling equipment and appliances.

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

Energy efficiency ratio (EER) – The ratio of net equipment cooling capacity in Btu/h (W) 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").

Exterior wall – An above-grade wall enclosing conditioned space. Includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof, and basement walls with an average below-grade wall area that is less than 50 percent of the total opaque and nonopaque area of that enclosing side.

Fenestration – Skylights, roof windows, vertical windows (whether fixed or moveable), opaque doors, glazed doors, glass block, and combination opaque/glazed doors.

Furnace, duct – A furnace normally installed in distribution ducts of air-conditioning systems to supply warm air for heating and which depends on a blower not furnished as part of the duct furnace for air circulation.

Glazing area – Total area of the glazed fenestration measured using the rough opening and including sash, curbing, or other framing elements that enclose conditioned space. Glazing area includes the area of glazed fenestration assemblies in walls bounding conditioned basements. For doors where the daylight opening area is less than 50 percent of the door area, the glazing area is the daylight opening area. For all other doors, the glazing area is the rough opening area for the door including the door and the frame.

Heat pump – A refrigeration system that extracts heat from one substance and transfers it to another portion of the same substance or to a second substance at a higher temperature for a beneficial purpose.

Heat trap – An arrangement of piping and fittings, such as elbows, or a commercially available heat trap, that prevents thermosyphoning of hot water during standby periods.

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 – Space within a building that is provided with a positive heat supply (see "Positive heating 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.

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

HVAC system components – HVAC system components provide, in one or more factory-assembled packages, means for chilling or heating water, or both, 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 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 is either electrically or heat operated and the refrigerant condenser is 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 shall be permitted to provide the heating function as a heat pump or by the use of electric or fossil-fuel-fired elements. (The word "equipment" used without a modifying adjective, in accordance with common industry usage, applies either to HVAC system equipment or HVAC system components.)

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 or the effect of differences in the indoor and outdoor air density or both ARI 310/380.)

Insulating sheathing – An insulating board having a minimum thermal resistance of R-2 of the core material.

Integrated part-load value (IPLV) – A single number 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 walls – Interior walls covered by Section 802.2.9 are those walls not on the exterior of the building and that separate conditioned and unconditioned space.

Labeled – Devices, equipment, appliances, assemblies, or materials to which have been affixed a label, seal, symbol, or other identifying mark of a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and by whose label the manufacturer attests to compliance with applicable nationally recognized standards.

Listed – Equipment, appliances, assemblies, or materials included in a list published by a nationally recognized testing laboratory, inspection agency, or other organization concerned with product testing, inspection, and evaluation.

Low-voltage lighting – Lighting equipment that is powered through a transformer such as cable conductor, rail conductor, and track lighting.

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

Manual – Capable of being operated by personal intervention (see "Automatic").

Outdoor air – Air taken from the outdoors and, therefore, not previously circulated through the system.

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 single room or zone). It includes heating capability by hot water, steam, or electricity. (For the complete technical definition, see ARI 310/380.)

Packaged terminal heat pump – 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 ARI 310/380.)

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 that continually maintain air temperatures of 85°F (29°C) or lower within the space during normal operation. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of this code.

Positive heat supply – Heat deliberately supplied to a space by design, such as through a supply register, radiator, or heating element. 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 that continually maintain an air temperature of 50°F (10°C) or higher within the space during normal operation. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of this code.

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 or access equipment (see "Accessible").

Roof assembly – A roof assembly shall be considered to be all roof/ceiling components of the building envelope through which heat flows, thus creating a building transmission heat loss or gain, where such assembly is exposed to outdoor air and encloses conditioned space. The gross area of a roof assembly consists of the total interior surface of all roof/ceiling components, including opaque surfaces, dormer and bay window roofs, treyed ceilings, overhead portions of an interior stairway to an unconditioned attic, doors and hatches, glazing and skylights exposed to conditioned space that are horizontal or sloped at an angle less than sixty (60) degrees (1.1 rad) from the horizontal (see "Exterior wall"). A roof assembly, or portions thereof, having a slope of 60 degrees (1.1 rad) or greater from horizontal shall be considered in the gross area of exterior walls and thereby excluded from consideration in the roof assembly. Skylight shaft walls 12 inches (305 mm) in depth or greater (as measured from the ceiling plane to the roof deck) shall be considered in the gross area of exterior walls and are thereby excluded from consideration in the roof assembly.

Screw lamp holders – A lamp base that requires a screw-in-type light such as an incandescent or tungsten-halogen bulb.

Skylight – Glazing that is horizontal or sloped at an angle less than sixty (60) degrees (1.1 rad) from the horizontal (see "Glazing area").

Slab-on-grade floor insulation – Insulation around the perimeter of the floor slab or its supporting foundation when the top edge of the floor perimeter slab is above the finished grade or 12 inches (305 mm) or less below the finished grade.

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 × ft^2 × °F) [W/(m^2 × K)].

Thermal resistance (R) – The reciprocal of thermal conductance (h × ft^2 × °F/Btu) [(m^2 × K)/W].

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 difference between the warm-side and cold-side air films (Btu/h × ft^2 × °F) [W/(m^2 × K)]. The *U*-factor applies to combinations of different materials used in series along the heat flowpath, single materials that comprise a building section, cavity airspaces, and surface air films on both sides of a building element.

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

Unitary cooling and heating equipment – One or more factory-made assemblies that include an evaporator or cooling coil, a compressor and condenser combination, and that shall be permitted to include a heating function as well. When heating and cooling 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 that 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 heat pump equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

Ventilation – The process of supplying or removing air by natural or mechanical means to or from any space. Such air shall be permitted to be conditioned or unconditioned.

Ventilation air – That portion of supply air that comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space (see ASHRAE 62 and definition of "Outdoor air").

Window projection factor – A measure of the portion of glazing that is shaded by an eave or overhang.

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

Chapter 1

IECC Commercial Inspection Overview

Field inspections are necessary to ensure that required materials and equipment are properly installed at the site and are in accordance with the approved building plans, specifications, or documentation. This section provides guidance to field inspectors performing site inspections on commercial buildings that must comply with the 2000 *International Energy Conservation Code*® (IECC®). Because the number and types of inspections vary throughout the country, you are encouraged to customize these guidelines for your jurisdiction.

This section at times refers to code-related information that was documented and submitted prior to plan review. The code requires this information to be provided on the plans and specifications (*see Section 104.2 of IECC*). For simplicity, the workbook refers to "plans." However, this same information can instead be provided on specifications, schedules, and/or other documents accepted by your jurisdiction.

The IECC focuses on four separate building energy using systems for commercial code compliance. The building systems covered include:

- Building Envelope
- Mechanical Systems
- Service Water Heating Systems
- Lighting Systems

Inspections for the provisions under each of the energy systems listed above will typically be handled during the normal inspection process by the appropriate inspector. For example, the mechanical inspector will inspect for proper duct sealing after the ducts have been installed in the building. The electrical inspector will verify that lighting control requirements have been met after installation of the controls has been completed. Inspection for each of the features should coincide with site visits typically required for general structural, mechanical, and electrical inspections.

You can use the *Field Inspection Checklists* (located in the Appendix) provided with this workbook to verify energy features. The checklists are divided into sections that reflect the four separate energy using systems in the building. For example, the checklist for the building envelope identifies insulation and glazing features that must be inspected in addition to air sealing requirements. The checklists are designed to be used during both plan review and field inspection. During the plan review process specific information pertaining to energy code compliance can be recorded. The inspector can then use the inspection form as a guide to ensure that each of the features used to make the building comply with the code is verified.

Chapter 2

Pre-Inspection

Before beginning the field inspection, verify that the approved building plans, specifications, or documentation are on site. Ensure that the plans and documentation have been checked for compliance with the energy code. The following minimum information should be included on the building plans (*see IECC Section 104.2*):

- Building envelope system information including:
  - Insulation *R*-values
  - Glazing *U*-factors
  - Glazing solar heat gain coefficient (SHGC) values
  - Rough opening of windows and skylights
  - Plan notes about air sealing and vapor retarders (if applicable)
- Mechanical system information including:
  - Equipment schedule listing the make and model of the equipment and other information pertinent to compliance with the mechanical requirements within the IECC
  - Duct insulation *R*-values and plan notes about duct sealing
  - Mechanical system control schematic
- Service water heating system information including:
  - Piping insulation levels
  - Heat trap requirements
  - Circulation loop system controls
- Lighting system information including:
  - Switching diagrams
  - Lighting schedule with fixture, bulb and ballast type, number of bulbs per fixture, and fixture wattage
  - Exterior lighting bulb and ballast type, and type of control.

The best place for this information is on the building plans but you may also find this in attached compliance documentation or specifications. The building plans, specifications, and compliance forms should provide you with all the information necessary to properly perform a field inspection.

As an alternative, an energy sheet can be added to the plan set that contains all the information necessary for energy code compliance.

Chapter 3

Building Envelope

First, check the energy provisions for building envelope compliance. Before we discuss these in detail, it's important to understand what comprises the building envelope. The building envelope separates conditioned space from unconditioned space or the outdoors. Conditioned space is the area in the building that you are heating or cooling.

The parts of the building envelope include the roof assembly; the walls between conditioned space or unconditioned space and the great outdoors; and the floor, whether it be slab-on-grade, a raised floor over a crawlspace, or over an open area such as a parking garage (Figure 1).

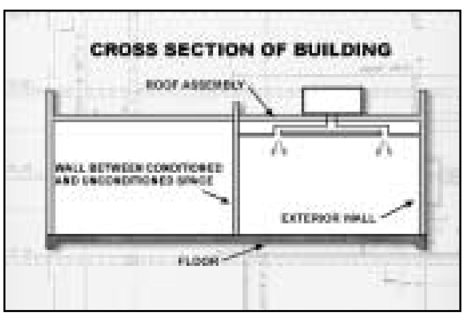

Figure 1

The envelope requirements focus on four major components:

1. Moisture protection
2. Air leakage
3. Insulation
4. Glazing

Moisture Protection

In many parts of the country, vapor retarders must be installed in all nonvented framed areas in ceiling, wall, and floor assemblies (*see IECC Section 802.1.2*). Nonvented areas are framed cavities without vents or other openings to allow free air movement. Vapor retarders control the entry of water vapor into building assemblies. Certain climates within the country are defined as hot and humid by the IECC and installation of a vapor retarder will not be required. When a vapor retarder is necessary, the IECC requires that it be installed on the "warm-in-winter" side of the insulation: that typically means between the insulation and the inside of the building. Check the IECC to determine if a vapor retarder is required in your location.

Foil and craft-backed insulation, polyethelene sheathing, or vapor retarder paint will work as a vapor retarder as long as it has a *maximum* perm rating of 1.0 (Figure 2). Vapor retarders should be installed with no holes or gaps. Holes or gaps will allow moisture to migrate into the unvented wall cavities and damage the integrity of the structure over time.

The code also allows the use of other methods for avoiding condensation in unventilated spaces. These must be approved by the building official.

Figure 2

Air Leakage

It is important to reduce the amount of air leakage into and out of a building. Air leakage will cause the HVAC system to run more often and longer, and still leave the building uncomfortable to be in.

There is no specific code language that precisely dictates how a leak should be sealed, or how to judge the quality of a seal (*see IECC Section 802.3.2*). To spot a potential air-leakage site, look along cracks in the building envelope for daylight. If you see daylight you have an air leak. Remember, air leaks can be introduced in any stage of construction so it is always a good idea to spot check even after the initial inspection for air leakage.

Air leaking into and out of the wall, ceiling, and floor systems can carry water vapor that will condense within the framing cavities. Air movement carries significantly more moisture than vapor diffusion. This condensed water can then cause mold growth and rot within the cavities, shortening the life span of the structure.

Openings in the building envelope are necessary to accommodate gas, plumbing, refrigerant, or electrical lines. Any penetration of the envelope – ceilings, walls, floors – should be sealed with caulk or expanding foam to ensure a continuous air seal around the opening (See Figure 3). The gap between the rough opening and windows and doors should also be sealed. Low-expanding foams, soft chink, or backer rod with caulk are good air sealers around windows and doors. Fiberglass batt insulation is not an appropriate air sealer, as shown in Figure 4.

There are several places where air leakage can occur:

- Exterior joints around window and doorframes
- Between wall sole plates, floors, and exterior-wall panels
- Openings for plumbing, electrical, refrigerant, and gas lines in exterior walls, floors, and roofs
- Openings in the attic floor (such as where ceiling panels meet interior and exterior walls and masonry fireplaces)
- Service and access doors or hatches
- All similar openings in the building envelope

Site built windows and doors must be weather-stripped or sealed to prevent air leakage. A stained glass window installed in a church is an example of a site built window.

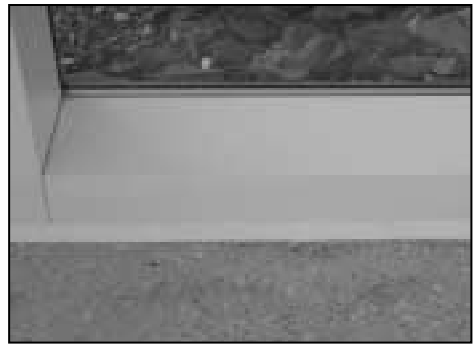

Figure 3

Figure 4

Below-grade Wall Insulation

Some parts of the country require below-grade wall or slab-edge insulation.

A below-grade wall is defined as a basement wall or first story wall that is at least 85 percent below grade (*see IECC Section 802.1.1.2*). Below-grade walls have lower insulation *R*-value requirements than above-grade walls (*see IECC Section 802.2.8*). Below-grade wall insulation can be installed on the interior of the wall or on the exterior as foam boards. In all cases, the insulation must be installed to the top of the foundation wall (See Figure 5). Check the building plans and documentation to determine the vertical distance that the insulation must extend down from the top of the below-grade wall.

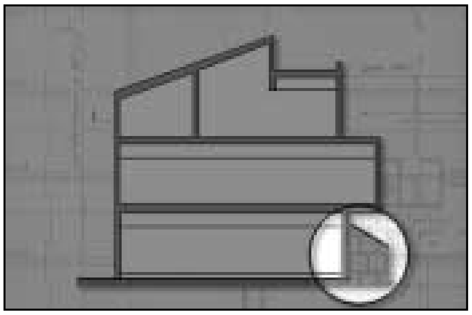

Figure 5

For insulation installed on the exterior of the below-grade wall, check the insulation *R*-values printed on the face of the exterior foam boards and compare that to what is called for on the plans or documentation. The best time to inspect for this is before the insulation is covered with backfill. The *R*-value will usually be listed as *R*-value per inch thickness or the rated *R*-value for the product will be printed on the foam board. If the *R*-value is not shown, the installation contractor should provide verification of the insulation *R*-value. Types of insulation installed on the exterior of the wall include extruded polystyrene boards, molded expanded polystyrene (MEPS) boards, and fiberglass or MEPS drainage boards.

The code also requires that exterior below grade wall insulation exposed to outdoor air be covered with a rigid, opaque, and weather-resistant protective covering (*see IECC Section 102.4.1*). This cover will prevent the degradation of the insulation's thermal performance. The cover must extend 6 inches below the grade. Materials that can be used include exterior grade plastic, fiberglass, galvanized metal or aluminum flashing, or a cementitious coating.

The perimeter joist directly connected to the foundation wall must also be insulated. Insulation on the interior of the wall will typically be installed between studs. Verify that the *R*-value of the installed insulation matches what is called for on the plans or the compliance documentation.

Slab-edge Insulation

As with below-grade wall insulation, inspect slab-edge insulation before it is covered with either backfill or concrete. The inspector must ensure that the correct insulation *R*-value has been installed and that the insulation is placed at the proper vertical and horizontal distances (*see IECC Section 802.2.7*).

To verify that the correct *R*-value has been installed, compare the *R*-value printed on the insulation with that called out on the approved building plans or compliance documentation (see Figure 6).

There are several ways in which insulation may be installed on the slab edge. Slab-edge insulation may be placed on the inside of the foundation stem wall or on the exterior of the wall. The insulation must extend from the top of the slab downward or downward and horizontally for the required minimum distance. Insulation that extends horizontally away from the slab, should be covered by either pavement or a minimum of 10 inches of soil. Check the plans and compliance documentation to determine the depth.

The code also requires that exterior slab-edge insulation that is exposed to outside air be covered with a rigid, opaque, and weather-resistant protective covering. This cover will prevent the degradation of the insulation's thermal performance. The cover must extend 6 inches below the grade. Materials that can be used include exterior grade plastic, fiberglass, galvanized metal or aluminum flashing, or a cementitious coating (see Figure 8).

Raised Floor Insulation

You may also encounter a raised floor over a crawl space or over outdoor air (see Figure 9). This includes buildings over a garage and cantilevered floors. This must also be insulated per the requirements in *Section 802.2.6 of the IECC*. There are two items to check when inspecting raised floor insulation. First, verify that the

Figure 6

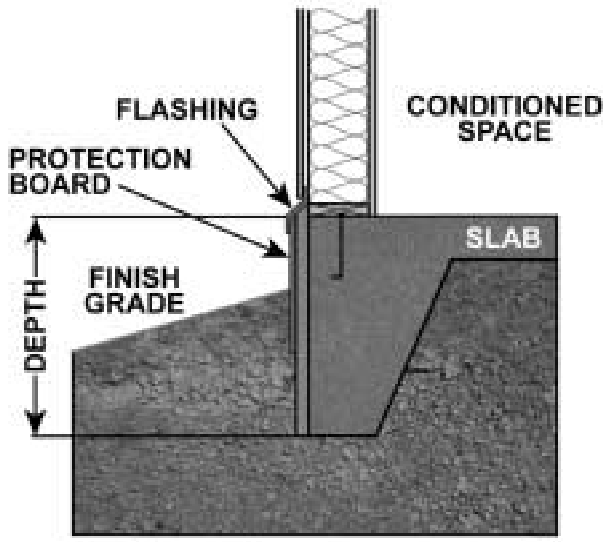

Figure 7

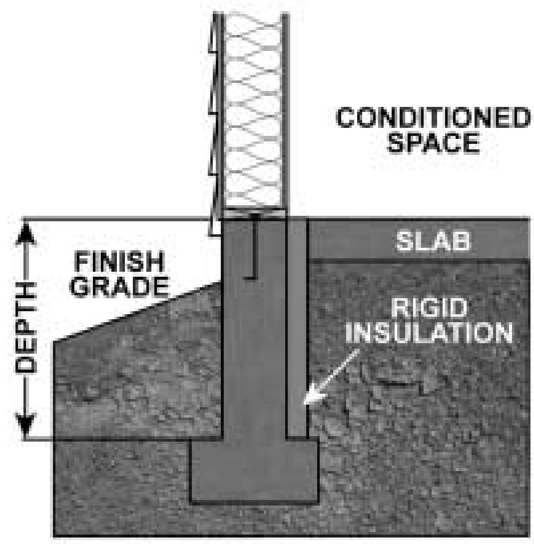

Figure 8

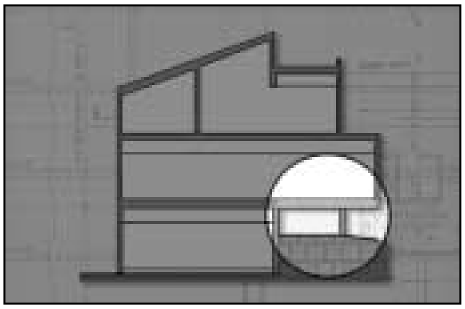

Figure 9

R-value of the installed insulation meets or exceeds that shown on the building plans and that it fills the joist cavity completely.

If rigid board insulation is installed, verify that the *R*-value printed on the insulation matches what is called for on the plans. For sprayed-on insulation, check the insulation certificate to verify that the installed *R*-value meets or exceeds what is call for on the plans.

Next, check to ensure that the insulation is properly supported and installed. Insulation between framing should be installed with no gaps between the insulation and the subfloor. Properly installed floor insulation should be flush against the subfloor, with the vapor retarder (where required) against the subfloor. Vapor retarders are only required in unvented floor spaces and must have a perm rating of 1.0 or less. Twine, metal rods, wire, and netting are common materials used for supporting insulation and ensuring that the insulation remains in place for the life span of the building. Rigid board insulation should be installed with a good mechanical bond between the floor and the insulation. Spray-on applications must be installed with no gaps in the insulated surfaces.

Exterior Wall Insulation

The best time to inspect for wall insulation is before the sheetrock is installed in the building. Two questions need to be answered during this inspection. First, has the right level of insulation been installed in the building? And second, has it been installed correctly? All walls between conditioned space or unconditioned space and the outdoors must be insulated (*see IECC Sections 802.1.1.1 and 802.2.1*). This includes:

- exterior walls
- kneewalls in attics
- perimeter joists
- walls between a conditioned space and an unconditioned space such as a warehouse
- skylight wells

Check the approved plans or the compliance documentation for the required *R*-values of the insulation.

Different types of insulation for framed walls may be encountered in the field. These include: fiberglass batts, rigid foam boards, and blown-in insulation. Fiberglass insulation *R*-values must be printed on the craft backing of the insulation or on the insulation itself for unfaced batts. For blown-in or sprayed insulation, the installer is required to provide a certification of the installed density and *R*-value (see Figure 10). This certification should be posted at the job site.

Ensuring that insulation is installed properly is important to the overall energy performance of the building and can also affect the durability of the wall structure.

Insulation should not be compressed behind wiring or plumbing. Compressed insulation will have a reduced *R*-value, lowering the efficiency of the insulation.

Also, be sure that insulation fills the entire cavity. Batts that are cut too short will leave voids in the wall reducing effectiveness of the insulation. For continuous insulation, make sure there are no voids and that the insulation is well bonded to the outside of the framing.

While not a code requirement, in some climates it is important to install insulation in exterior corners and on, or in headers over doors and windows. This can eliminate excess heat transfer through the surfaces. The perimeter joist between floors must also be insulated to the required *R*-value.

Concrete masonry unit walls may be insulated by filling the empty core with perlite, vermiculite, or some other insulative material. In some cases, even with filled cores, these wall types require additional insulation. The insulation will either be installed between framing members, typically on the inside of the wall, or as a continuous rigid board insulation on the inside, or outside of the wall (see Figure 12). In either case, make sure that the insulation is installed properly and that the insulation *R*-value matches the plans or documentation.

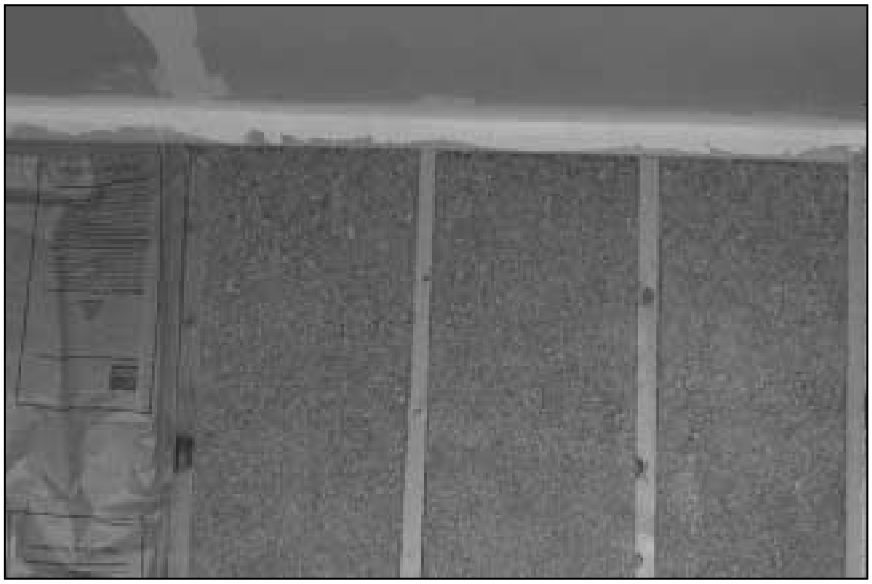

Figure 10

Figure 11

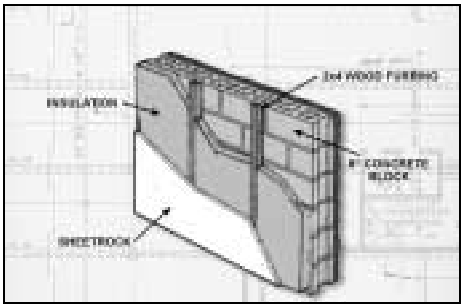

Figure 12

Glazing

Glazing plays a major role in energy code compliance. More glass typically means greater insulation levels are needed to offset the energy use caused by the glazing.

There are three key elements that need to be inspected:

- Glazing area
- Glazing solar heat gain coefficient
- Glazing *U*-factor

Glazing Area

Let's look at glazing area first. Use the approved building plans to compare the installed glazing or roughed out opening with what is shown on the approved plans. Look for added windows, skylights, glass doors, or windows larger than those shown on the plans. Any increase in window area could cause non-compliance. New documentation will need to be submitted.

Glazing Solar Heat Gain Coefficient (SHGC)

The solar heat gain coefficient (SHGC) is a measure of how much solar gain is transmitted through the window by solar radiation. With a lower number, less sunlight and heat can pass through the glazing (see Figure 13). The SHGC is based on the properties of the glazing material, the number of panes of glass in the window, and the window operation (either openable or fixed). A glazing unit with a low SHGC will help reduce the air conditioning energy use during the cooling season.

Different window tints have different SHGCs. This information should be listed in the window schedule on the building plans and with manufacturer's data on the window label. The National Fenestration Rating Council (NFRC) labels list the SHGC value (*see IECC Section 102.5.2 and Figure 14*). If no NFRC labels are present on the windows, Table 102.5.2(3) can be used to determine a default SHGC value for the window (see Figure 15). Compare the window frame type and operation, number of glazings and window tint to determine the default SHGC. For example, a dual glazed, fixed metal-framed window, with a bronze tint will have a SHGC of 0.55. If the default SHGC is less than or equal to that shown on the plans, the window complies with the code (*see IECC Section 802.2.3*).

The SHGC is gradually replacing the older index, shading coefficient (SC) in product literature and design standards. If you are using glass whose performance is listed in terms of SC, you may convert to SHGC by multiplying the SC value by 0.87.

The SHGC requirement of a window is also affected by overhangs on a building (*see IECC Section 802.2.3*). The code uses a term called a projection factor to determine how well the overhang

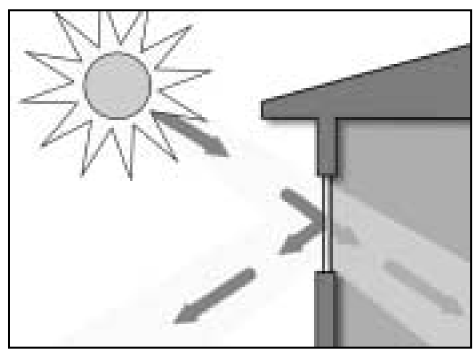

Figure 13

Figure 14

TABLE 102.5.2(3)
SHGC DEFAULT TABLE FOR FENESTRATION

PRODUCT DESCRIPTION	SINGLE GLAZED				DOUBLE GLAZED			
	Clear	Bronze	Green	Gray	Clear + Clear	Bronze + Clear	Green + Clear	Gray + Clear
Metal frames								
Operable	0.75	0.64	0.62	0.61	0.66	0.55	0.53	0.52
Fixed	0.78	0.67	0.65	0.64	0.68	0.57	0.55	0.54
Nonmetal frames								
Operable	0.63	0.54	0.53	0.52	0.55	0.46	0.45	0.44
Fixed	0.75	0.64	0.62	0.61	0.66	0.54	0.53	0.52

Figure 15

shades glazing. The projection factor is calculated by measuring the distance from the window to the farthest-most edge of the overhang and dividing that by the distance from the bottom of the window to the lowest point of the overhang.

See Figures 16 and 17, which demonstrate how to calculate a projection factor. For the purposes of this example, assume that the vertical dimension is 8 feet.

The horizontal dimension is measured from the surface of the glazing to the farthest-most point of the overhang (see white lines in Figure 17). For the purposes of this example, assume that the vertical dimension is 5 feet. To calculate the projection factor divide the horizontal dimension by the vertical dimension or:

Projection Factor =
5 feet (horizontal) / 8 feet (vertical) = 0.63

The greater the projection factor, the better the window is shaded. The better the window is shaded, the less important the solar heat rejection qualities of the window. So a window with a higher SHGC value can be used to comply with the code.

If overhangs are shown on the building plans, ensure that they have been installed according to the design. They may have been placed on the building to reduce the SHGC requirement of the windows that they are shading.

Glazing *U*-Factors

The next requirement for windows, skylights, and both glazed and unglazed doors, is a *U*-factor requirement. The *U*-factor is a measure of how well the assembly conducts heat. The lower the number, the better the assembly acts as an insulator. As an example, an aluminum window with two panes of glass may have a *U*-factor of 0.87. Vinyl or wood, on the other hand, have *U*-factors less than 0.55. This information should be listed in the window schedule on the approved building plans, with manufacturer's data on the window label or on the documentation.

The code requires windows, glass doors, and skylights to be rated by the National Fenestration Rating Council and to have labels that show the rated *U*-factor for the glazing unit (*see IECC Section 102.5.2*). These labels make it easy for an inspector to verify that the installed window unit meets the *U*-factor requirement called out on the plans or documentation (see Figure 18). The *U*-factor listed on the NFRC labels must be less than or equal to those shown on the approved building plans or documentation. Use the nonresidential designation on the NFRC label.

If the windows and glass doors are not rated, Table 102.5.2(1), *U*-Factor Default Table for Windows, Glazed Doors and Skylights, can be used. By using the frame material, the number of panes of glass and the operation of the window (either fixed or openable) you can determine the default *U*-factor for a window, glass door, or skylight. For example, a vinyl framed, double glazed, operable window has a default *U*-factor of 0.55 (see Figure 19).

Roof /Ceiling Insulation

The insulation requirements on a roof/ceiling assembly will vary depending on how the roof is constructed. For example, a concrete deck will have a continuous insulation requirement whereas a roof using a truss system will probably use

Figure 16

Figure 17

Figure 18

TABLE 102.5.2(1)
***U*-FACTOR DEFAULT TABLE FOR WINDOWS, GLAZED DOORS AND SKYLIGHTS**

FRAME MATERIAL AND PRODUCT TYPE[a]	SINGLE GLAZED	DOUBLE GLAZED
Metal without thermal break		
Operable (including sliding and swinging glass doors)	1.27	0.87
Fixed	1.13	0.69
Garden window	2.60	1.81
Curtain wall	1.22	0.79
Skylight	1.98	1.31
Site-assembled sloped/overhead glazing	1.36	0.82
Metal with thermal break		
Operable (including sliding and swinging glass doors)	1.08	0.65
Fixed	1.07	0.63
Curtain wall	1.11	0.68
Skylight	1.89	1.11
Site-assembled sloped/overhead glazing	1.25	0.70
Reinforced vinyl/metal clad wood		
Operable (including sliding and swinging glass doors)	0.90	0.57
Fixed	0.98	0.56
Skylight	1.75	1.05
Wood/vinyl/fiberglass		
Operable (including sliding and swinging glass doors)	0.89	0.55
Fixed	0.98	0.56
Garden window	2.31	1.61
Skylight	1.47	0.84

a. Glass block assemblies with mortar but without reinforcing or framing shall have a *U*-factor of 0.60.

Figure 19

insulation installed between the framing members (*see IECC Section 802.2.4*).

Check the approved building plans or documentation for the required insulation *R*-value. In buildings using a metal joist system with insulation installed between the joists, the insulation must completely fill the voids between the framing members. The IECC contains insulation *R*-values to be printed on the insulation for batt and rigid board insulation.

Attics utilizing blown-in insulation have additional requirements. The IECC contains provisions that will make inspecting for blown-in insulation quick and easy. First, check for the attic insulation certificate near the opening of the attic. This certificate will include the following information:

- *R*-value of the installed thickness
- Initial installed thickness
- Settled thickness
- Coverage area
- Number of bags installed

Verify that the *R*-value listed on the certificate meets or exceeds the *R*-value called for on the approved plans. Then verify that the correct thickness has been installed. This can be done by checking the insulation markers installed in the attic as shown in Figure 20.

These markers are required to be spaced every 300 square feet and are marked with the minimum initial installed thickness and the minimum settled thickness. Insulation manufacturers will typically provide markers for use with their insulation. Check to see that the insulation is installed uniformly to an even thickness throughout the attic and that it extends over the top of the exterior wall.

Baffles should be installed at each soffit, cornice, or eave vent to direct vent air up and over the top of the insulation. This will prevent windwashing. For blown-in installations with extra thick insulation (e.g., an R-49), it might be necessary to extend the baffles up and over the insulation.

Roof assemblies constructed using metal purlins for support may require thermal blocks

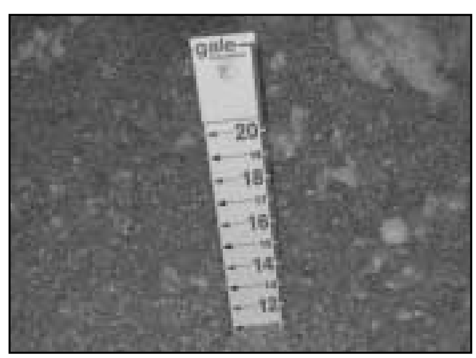

Figure 20

to separate the roof deck from the purlin. Thermal blocks are installed to provide a space for the insulation to drape over the top of the purlin without compressing the insulation. A thermal block consists of foam blocks or other materials/techniques that prevent heat from migrating from the purlin directly to the metal roof sheet. Compressed fiberglass batt insulation does not qualify as a thermal block. If the plans or documentation call for thermal blocks, verify that these have been installed on top of the purlins.

Chapter 4

Mechanical Systems

The IECC includes provisions for most HVAC system types. Single zone unitary systems are covered as well as multiple zone air and water systems. The more complex the system, the more requirements apply to that system: a single-zone unitary system has fewer requirements than a complex system made up of chillers, boilers, and fan coil units.

The IECC focuses on five key elements to ensure that the system designed is efficient. They include:

- Minimum equipment efficiency is required for all installed equipment
- Proper equipment sizing and selection
- Minimizing distribution losses by requiring duct insulation, sealing, and hydronic piping insulation
- Installing controls to give the building occupants the opportunity to operate the HVAC system in an efficient manner
- Cooling, using the cool outdoor air to reduce cooling energy.

Chapter 8 of the IECC is divided into requirements for simple and complex systems. The mechanical section of this workbook will present the requirements for both types. System controls will be presented together, focusing first on the simple system control requirements followed by the complex requirements.

Controls - Thermostats (Simple Systems)

The IECC requires that each heating and cooling system be controlled by a solid-state programmable thermostat. The thermostat should have the capability to set back or shut down the system during periods of non-use. This includes the capability to set back or shut down the system based on the time of day or day of the week (see Figure 21). This will reduce the energy use of the HVAC system during periods when the space is unoccupied.

Check the plans for the make and model number of the thermostat selected for the system. Verify that the installed thermostat is called for on the plans. If there is a change out in the field, ask for the manufacturer's specifications.

Figure 21

Controls - Thermostats (Complex Systems)

Each zone must be provided with an individual temperature control (*see IECC Section 803.3.3*). There are several requirements for thermostats listed in *IECC Section 803.3.3.2 and 803.3.3.3*.

Multiple perimeter zones designed to offset building envelope heat losses or gains may be operated from the same thermostat for each building exposure if the thermostat is located within the zone served by the system.

Check the plans for the make and model number of the thermostat(s) selected for the system. Verify that the installed thermostat(s) are those called for on the plans. If there is a change out in the field, ask for the manufacturer's specifications.

Controls - Heat Pump Thermostats

Heat pumps require special heat pump thermostats. They must be programmable, and, if supplementary electric resistance heaters are installed, they must prevent supplementary electric resistance heat from coming on when the heat pump can handle the load (*see IECC Section 803.2.3.1*).

This intelligent recovery allows a building to return to comfortable conditions after a period of set back using the efficient heat pump rather than less efficient electric resistance heat. If in doubt, ask for the manufacturer's thermostat specifications.

Controls - Hydronic Systems

Hydronic heating and cooling systems typically consist of a boiler and chiller to provide heated or chilled water for space conditioning. The heated or chilled water is then pumped to individual heating or cooling units for each space within the building. The chiller and boiler system is typically sized for the largest load on the building for either heating or cooling, but typically the heating and cooling loads represent only a portion of the full load or "part load."

A significant energy savings can be realized if the chiller is allowed to provide warmer water to the space or the boiler is allowed to provide cooler water and still meet the loads.

The IECC requires part load controls for systems greater than 600,000 Btu/hr. Two options are available to meet this requirement. Temperature reset controls can be installed on the system to either raise the chiller temperature or lower the boiler temperature based on the load on the space. The approved mechanical plans should include a control schematic for the system that calls out the reset controls. Verify that the controls in the field match those shown on the plans.

Another option is to reduce the system flow by at least 50 percent of the design flow by using either an adjustable speed drive on the pumps or multiple staged pumps (see Figure 22). Again, check the approved mechanical plans and specifications for the strategy used to meet the reset requirements.

Figure 22

Controls - Economizer

Cooling units with a capacity over 90,000 Btus or 3,000 cfm are required to have an economizer. Economizers allow the unit to use outdoor air to cool the building when the outdoor conditions are favorable. This is done with sensors and controls that shut down the compressor and take advantage of outside conditions. Check the building plans or documentation to determine if an economizer is required. If an economizer is required, verify that one has been installed by looking inside the cabinet for the economizer controls (see Figure 23).

Figure 23

With a split system, where you have an air handler inside the building, outdoor air must be brought in through a duct to the return side of the system. Check the mechanical plans to ensure that the outdoor air system on the plans matches what has been installed.

It is also possible to trade off the economizer requirement by installing cooling equipment with a higher energy efficiency ratio (EER). This information should be called out on the mechanical plans. Verify that the make and model number of the installed cooling system match those of the planned system. If there is any question, ask to see the manufacturer's specifications.

Economizers for single zone unitary systems are not required in Climate Zones 1a, 1b, 2a, 2b, and 3b. These climate zones represent areas in the country with climates that are warmer than average with higher humidity levels. Installing an economizer in these climates is typically not cost effective.

There are several different types of economizers that may be encountered in the field. Single zone unitary systems utilize air-side economizers. In this configuration the outdoor air dampers are open to provide 100 percent outside air to the space. The exhaust air is also open to exhaust 100 percent of the return air from the building. During normal operation the outside air and exhaust damper is closed to provide the minimum outdoor air requirements for the space.

Water-side economizers may be included in larger built-up systems. The strainer cycle economizer (see Figure 24) is an example of a water-side economizer. A cooling tower is used to cool the cold water supply that is then run through coils to cool the supply air. The water cycle bypasses the chiller in this arrangement and uses the cooling tower to provide 100 percent of the cooling for the building. When the cooling tower can no longer handle the load, the water will be diverted through the chiller, by-passing the cooling tower.

Figure 25 shows another example of a water-side economizer. This economizer utilizes a heat exchanger to pre-cool the cold water return before it enters the chiller. This allows the cooling tower to provide 100 percent of the cooling load of the space, or it can work in conjunction with the chiller, pre-cooling the water before entering the chiller. This is considered an integrated economizer cycle.

The air pre-cooling water economizer (see Figure 26) uses water circulated through a cooling tower to pre-cool the return air before the air hits the DX coil. The water then is pumped through the condensing unit to remove the heat, which is then discharged at the cooling tower. This system is considered an integrated system as both the cooling tower and condenser can operate concurrently.

Controls - Lock Out and Staging

The IECC requires heating and cooling systems to be sized based on load calculations for the building (*see IECC Section 803.3.1.1*). While

Economizer Types
Water Side Economizers
"Strainer Cycle"

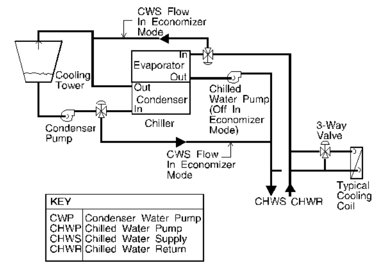

Figure 24

Economizer Types
Water Precooling Water Economizer with
Two-Way Valves

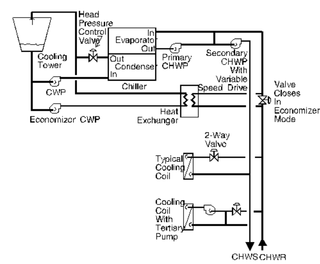

Figure 25

Economizer Types
Air Precooling Water Economizer

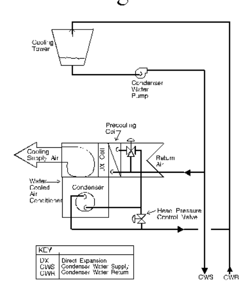

Figure 26

the heating, cooling, and ventilation loads and equipment selected to meet the loads will be verified during the plan review process, there are two possible control requirements that the inspector will need to verify if an exception to sizing requirement is taken (*see IECC Section 803.3.1.1*).

The heating and cooling load calculations may be exceeded if stand-by equipment is installed, provided controls are installed to lock out the standby equipment while the primary system is operating.

As another option, multiple HVAC units may be installed that are designed to operate sequentially based on the load. The total capacity of these units may exceed the design load since they will operate based on the building load. In both cases, the inspector must verify that the proper controls have been installed to either lock out the stand-by equipment or provide staging controls for the systems designed to operate sequentially. Verify that the controls already installed match those shown on the control schematic on the mechanical plans.

Exhaust and Outdoor Air Supply Dampers

The IECC requires that all outdoor air supply and exhaust ducts greater than 3,000 cfm be provided with a means to reduce or shut off the airflow when the system is not in use. This will help to limit infiltration of the building when the system is not operating there by reducing the load on the building HVAC system.

Common methods that may be used to meet this requirement include using either gravity type dampers or motorized dampers. Dampers with readily accessible manual controls can also be used to meet the requirement.

Check the approved mechanical plans to determine the type of damper that is installed to meet the requirement. Then verify that such damper is consistent with the type shown on the plans.

Variable Air Volume System Requirements

An example of a variable air volume (VAV) system is illustrated in Figure 27. VAV systems vary the amount of air supplied to a space instead of leaving the supply volume constant and varying the temperature of the air as is done

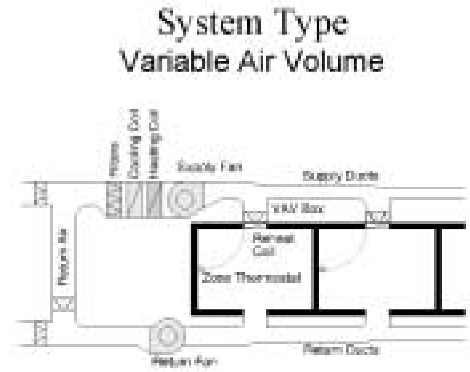

Figure 27

with constant volume systems. The air modulation is handled at the VAV boxes by use of dampers. From an inspection standpoint it is important to have an approved set of mechanical plans on site to ensure that the installed system replicates that shown on the plans.

Temperature reset is required to automatically reset the supply air temperature by 25 percent based on the difference between the supply air temperature and the room air temperature. For example, a cooling system with a design supply air temperature of 55° and a design space air temperature of 75° must reset supply air temperature by up to 5°F (0.25 x (75-55). Verify that the temperature reset control has been installed in accordance with the control schematic on the mechanical plans.

VAV fan motors are generally the largest energy-using component of HVAC systems. The IECC requires that individual VAV fan motors > 25 HP meet one of the following criteria (*see IECC Section 803.3.3.6*):

- It is driven by a mechanical or electrical variable speed drive. This will typically be cost effective for VAV systems with almost any fan type
- It is a vane-axial fan with a variable pitch blade, which provides excellent part load performance
- It has controls or devices resulting in a fan motor demand of ≤ 50 percent of the design wattage at 50 percent of the design airflow. This might include the use of:

– Forward-curved fan with discharge dampers
– Forward-curved centrifugal fan with inlet vanes.

The approved mechanical plans, specifications, or control schematic should call out the strategy that has been utilized to meet the fan motor requirement. Verify that what is shown on the plans has been installed in the field.

Duct Sealing

The IECC defines a duct system as a continuous passageway for the transmission of air. This includes both supply air and return air (*see IECC Section 202*). The code has specific duct sealing and insulation requirements. The following elements are considered part of the duct system:

- Ducts
- Duct fittings
- Dampers
- Plenums
- Fans
- Accessory air-handling equipment and appliances

Duct sealing and duct installation play an important role in the efficiency of the heating and cooling system. This may be one of the most important conservation features to check. The IECC requires that all joints, seams, and connections be securely fastened and sealed with (*see IECC Section 803.2.8 and 803.3.6*):

- Welds
- Gaskets
- Mastics (adhesives)
- Mastic plus imbedded fabric systems, or
- Approved tapes

Any unapproved tape (e.g., duct tape) is not permitted as a sealant on any ducts.

The duct sealing requirement applies to supply and return ductwork and to plenums that are formed by part of the building envelope. Proper duct sealing will ensure that correct quantities of heated or cooled air will be delivered to the space, and not be lost to unconditioned spaces or the outdoors through leaks in the ducts. This may be one of the most important conservation features to check. A properly sealed duct system will increase the comfort and lower the energy use of the building (see Figure 28).

For duct systems designed to operate at static pressures greater than 3 inches water gauge, documentation must be furnished demonstrating that 25 percent of the duct system has been tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual, with the rate of air leakage less than or equal to 6.0 as calculated by Equation 8-2 of the IECC (*see IECC Section 803.3.6*). The documentation must be provided to the inspector upon request.

Duct Insulation

Insulating ducts in unconditioned spaces and outside the building is the next portion of the duct requirements within the IECC (*see IECC Section 803.2.8*). All ductwork located outside the building must be insulated to a minimum *R*-8 value. For example, a duct located on top of a flat roof would be required to be insulated to this level. Ducts in an envelope assembly, such as a duct in an exterior wall, must have *R*-8 insulation installed between the duct and the building exterior. All ducts in unconditioned spaces must be insulated to at least an *R*-5. This includes both supply and return ductwork. But ducts are not required to be insulated if the temperature between the inside of the duct and the space that the duct passes through does not exceed 15° at design temperature.

The code also requires that the insulation *R*-value be printed on the duct insulation every three feet so it should be easy to compare the installed duct insulation *R*-value to what is shown on the plans.

HVAC Piping Insulation

All piping installed as part of a heating and cooling system will need to be insulated (*see IECC Section 803.3.7*). This would include refrigerant

Figure 28

piping as well as hydronic heating and cooling piping: e.g., refrigerant piping for a split system and piping from a chiller or boiler system. Table 803.3.7 of the IECC requires certain thicknesses of insulation based on the type of fluid and pipe diameter. Check the approved mechanical plans or documentation to determine the correct piping insulation thickness.

There are several exceptions to the piping insulation requirements. Typically, piping conveying fluids that have not been heated or cooled are exempt. Factory installed piping within an HVAC system is also exempt. The losses or gains attributed to this piping are already accounted for in the rated equipment efficiency. Table 803.3.7, shown in Figure 29, lists the minimum pipe insulation requirement. The table is based on a minimum *R*-value of 3.7 per inch thickness.

Air Balancing - Complex Systems

Air balancing is necessary to verify that each space served by a system receives the air volume designed for the space. The code requires that a means for air balancing be installed at each supply air outlet and zone terminal device (*see IECC Section 803.3.8.1*). This includes balancing dampers or other means of supply-air adjustment provided in the branch ducts or at each individual duct register, grille, or diffuser. Installing these devices provides the means to balance the system. Verify that devices used for balancing shown on the approved mechanical plans, typically on the ductwork layout, are installed in the duct system.

Operations and Maintenance Manuals

Operation and maintenance (O&M) manuals provide vital information *(see IECC Section 803.3.8.3)* to the building owner on how to properly operate the system as a whole and are required for complex HVAC systems. Verify during final inspection that this manual has been passed on to the building owner and that it contains the following information at a minimum:

- HVAC equipment capacity
- Equipment operation and maintenance manuals
- HVAC system control maintenance and calibration information, including wiring diagrams, schedules, and control sequence descriptions.
- A complete written narrative of how each system is intended to operate.

TABLE 803.3.7
MINIMUM PIPE INSULATION[a]
(thickness in inches)

FLUID	NOMINAL PIPE DIAMETER ≤1.5″	NOMINAL PIPE DIAMETER > 1.5″
Steam	1.5	3.0
Hot water	1.0	2.0
Chilled water, brine or refrigerant	1.0	1.5

For SI: 1 inch = 25.4 mm, Btu per inch/h · ft^2 · °F = W per 25 mm/K · m^2.

a. Based on insulation having a conductivity not exceeding 0.27 Btu per inch/h · ft^2 · °F.

Figure 29

Chapter 5

Service Water Heating Systems

Service water heating plays a small part in the energy use of a commercial building. There are only a few provisions that you need to check to ensure that the water heating system meets the requirements of the IECC.

The three primary requirements for service water heating systems are shown in Figure 30. They include:

- heat traps on non-circulating systems
- piping insulation
- controls on circulating pumps

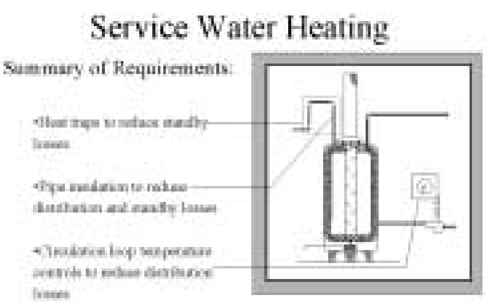

Figure 30

Heat Traps

Heat traps must be installed on all non-circulating water heaters (*see IECC Section 804.4*). Heat traps stop hot water from rising into the distribution pipes and forming a natural circulation loop. Heat traps are required in the inlet and outlet piping of noncirculating water heaters, shown in Figure 31. These may either be installed internally by the manufacturer, installed as an after market add-on or site-fabricated. Site-fabricated heat traps may be fabricated by creating a loop or inverted U-shaped arrangement to the inlet and outlet pipes. Check the manufacturer's literature if there is any question about an internal heat trap.

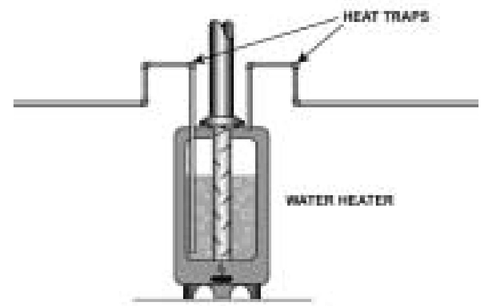

Figure 31

Piping insulation

Water heating piping must also be insulated (*see IECC Section 804.5*). For noncirculating systems without integral heat traps, the first 8 feet of piping must be insulated with at least $^1/_2$ inch of pipe insulation on the inlet and outlet side of the water heater. Circulation systems must have 1-inch pipe insulation installed on all piping. The insulation *R*-value must be at least 3.5 per inch thickness.

Controls

Systems that circulate hot water through the building must also have an automatic control that is capable of turning the pump off during the periods of non use (*see IECC Section 804.6*). This also includes controls for heat trace tape. Check the approved plumbing plans for the type of control used. The control may be as simple as an automatic time clock, as shown in Figure 32, that connects the pump or heat trace tape.

Figure 33

Chapter 6

Lighting Systems

Interior lighting plays a major role in the energy usage of a commercial building. An increased lighting load increases the capacity requirements for the mechanical cooling system. The lighting requirements focus on these elements:

- lighting controls
- tandem wiring
- interior lighting power
- exterior lighting efficacy

Lighting Control Requirements

Independent Switching

Each area enclosed by floor to ceiling partitions must have at least one lighting control to turn the lights on and off in the space (*see IECC Section 805.2.1*). This can be a standard light switch or an occupancy sensor. The control can be located in the space itself or it can be installed in a remote site that identifies the lights served and indicates their status, either on or off. Building occupants must have the ability to control the lights in their workspaces and to turn lights off when the spaces are not occupied. Check the approved lighting plans to verify that the switching that has been installed matches what is on the plans.

For example, a standard office space may have a switch inside the entrance of the space that would meet the intent of the code. A retail space may have the switch located in a storeroom, which would be considered in a remote location. Areas that are designated as security or emergency areas, that must be continuously lighted, are exempt from the independent switching requirements. Also, lighting in stairways or corridors that are elements of the means of egress are also exempt from the independent switching requirements.

Bi-level Switching

In addition to the independent switching requirements, each space must also be able to reduce the connected lighting load by at least 50 percent in a reasonably uniform illumination pattern (*see IECC Section 805.2.1.1*). For example, switching every other light fixture in a dropped ceiling would meet the bi-level switching requirement (see Figure 33). This will mean each space will have at least two switches. This will allow the occupant to better control the lighting in the space. Check the approved lighting plans to verify that the installed switching matches what is on the plans.

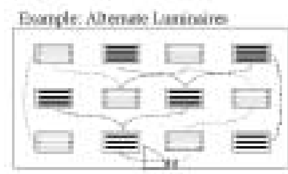

Figure 33

There are some exemptions to the bi-level illumination requirements. Spaces that are exempt include:

- areas that have only one luminaire
- areas that are controlled by occupancy sensing devices
- corridors, storerooms, restrooms, or public lobbies

Guest Room Switching

Hotel guest rooms have their own set of switching requirements (*see IECC Section*

805.2.1.2). All permanently wired lighting fixtures and switched receptacles, except in bathrooms, must be controlled by a master switch at the main entry door. Suites shall have a control at the entry of each room (see Figures 34 and 35).

The best time to inspect for this requirement is after the wiring has been installed and prior to installation of the sheet rock. Verify that the switching and wiring that is shown on the approved electrical plans has been installed.

Tandem Wiring Requirements

Frequently, one- or three-lamp florescent fixtures utilizing magnetic ballasts are installed in commercial buildings. The three-lamp fixtures may utilize two ballasts – one to drive the two outside bulbs and the other to drive the inside bulb. If there is more than one fixture in the space, the energy code requires that the ballast driving the one bulb be tandem-wired to an adjacent fixture (*see IECC Section 805.3*).

This requirement applies to recessed mounted fixtures located within 10 feet of each other, and pendant or surface mounted fixtures in continuous rows. Tandem wiring plan notes should be placed on the electrical plans if magnetic ballasted fixtures are proposed for the project (see Figure 36).

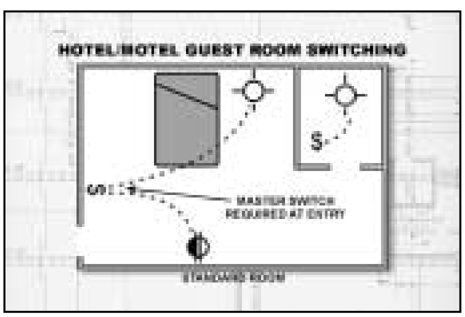

Figure 34

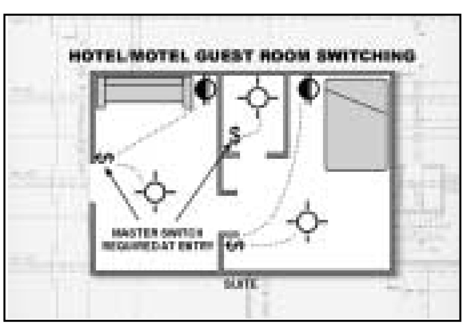

Figure 35

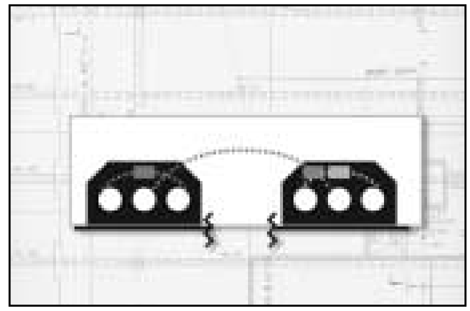

Figure 36

Fixtures that utilize electronic high-frequency ballasts are exempt from the requirement. Electronic high-frequency ballasted fixtures can drive three bulbs off of one ballast eliminating the need for two ballasts. Luminaires (fixtures) not located in the same space are also exempt from the requirement as are fixtures not on the same switch control.

Interior Lighting Power Requirements

The IECC sets limit on the quantity of lighting that can be installed in a building. This is presented in Table 805.4.2 of the IECC. Once the budget is determined, the lighting designed for the permitted space or building must not exceed this amount. It is the plan reviewers responsibility to review the plans and documentation to ensure that the lighting proposed for the building is less than or equal to the budget.

From an inspection standpoint, your job is to make sure that the installed lighting matches the approved electrical plans. Two items will need to be checked for this verification. First, check that the lighting technology installed matches what is on the plans. Installing a less efficient lighting source can have a great impact on lighting compliance because of the difference in wattages between inefficient and efficient lighting fixtures.

For example, a 48-inch three-bulb fluorescent fixture with T12 bulbs and magnetic ballasts typically uses about 125 watts. On the other hand the same fixture using more efficient T8 bulbs with electronic ballasts uses approximately 95 watts per fixture: a difference of 30 watts per fixture. For a large building, installing a less efficient fixture could significantly increase the load on the cooling system of the building and thereby increase the energy usage.

Second, check the number of fixtures that are installed. Verify that what is shown on the approved electrical plans and documentation matches what is installed in the field. For large buildings with a standard lighting layout, it is possible to spot-check rooms to verify compliance. For a more complicated lighting design with various fixture types and wattages, it may be necessary to conduct a more thorough fixture count.

The IECC allows additional lighting to be installed for:

- Visual display terminals
- Merchandise display lighting
- Decorative lighting
- Emergency and medical lighting

The additional lighting supplements the lighting levels installed for general lighting listed in Table 805.4.2. It is the plan reviewer's responsibility to verify that the additional lighting for the uses listed above complies with the IECC requirements. From an inspection standpoint, more time may be needed to verify that the additional lighting installed in the field is consistent with what is shown on the plans.

Exterior Lighting Requirements

Two provisions cover exterior lighting that will need to be inspected. The first requirement focuses on lighting controls. All exterior lighting must be controlled such that it is turned off during daylight hours. This can be achieved by the use of photocell controls and/or automatic time switches. Photocell controls are probably the most common, but if an automatic time clock is used, it must have a combination seven-day and seasonal daylight program adjustment and a minimum 4-hour power back-up (see Figure 37). Check the approved electrical plans for the make and model number of the proposed control. If the installed control does not match the plans, request the manufacturer's literature.

The second provision requires all exterior lighting supplied through the energy service of the building to be energy efficient. There is no limit to the amount of lighting that can be installed on the exterior of the building but must be rated at least 45 lumens/watt.

Not all commonly used exterior light sources will meet this requirement. For example, incandescent bulbs are rated at about 15 lumens/watt. Some mercury vapor lamps are rated below 45 lumens/watt. Exterior lighting that will meet this requirement includes fluorescent, compact fluorescent, metal halide, HID, and high-pressure sodium (see Figure 38).

Verify that the installed lighting type matches what is called for on the approved electrical plans and documentation for exterior lighting. If the installed lighting is rated at less than 45 lumens/watt it must be changed to a lighting source that will meet the requirement.

The graph shown in Figure 39 provides a comparison of various light sources and their lumens/watt or efficacy ratings. At the low end of

Figure 37

the ratings are incandescent and some mercury vapor lighting commonly used for building exteriors. If they are rated at less than 45 lumens/watt they cannot be used. Most compact fluorescent long-tube fluorescent, and high-pressure sodium lighting will meet the 45 lumens/watt requirement.

There are several exterior lighting usages that are exempt from the 45 lumens/watt requirement. Lighting approved because of historical, safety, signage or emergency considerations is exempt from the lighting efficacy requirement. If one of the exceptions is taken, it must be called out on the lighting plan.

Figure 38

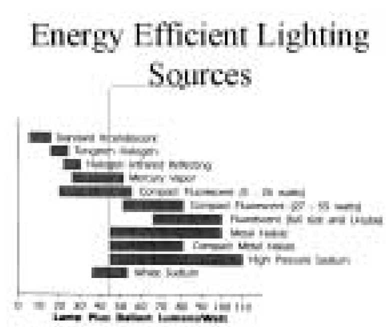

Figure 39

Appendix

Envelope Compliance Certificate for the IECC®

Simple Mechanical Compliance Certificate for the IECC®

Mechanical Compliance Certificate for Complex Systems for the IECC®

Lighting Compliance Certificate for the 2000 IECC®

Envelope Compliance Certificate for the IECC® *All Information Must be Filled in*

Section 1 Project Information

Project Name____ Permit Number ______________________________

Project Address____ Date ________________

Owner/Agent_____________________________________Telephone__________Checked By___________________

Documentation Author____ Telephone____________________

Submitted By______________________ Phone Number ______________ Date Submitted:________________

Department Use Only

Section 2 General Information

Building Floor Area:_______
Window – Wall Ratio (WWR): Gross Fenestration Area _____ ? Gross Above Grade Wall Area____ X 100____
Project Description: New Construction ____ Addition _____ Alteration _____ Unconditioned Shell ________

Section 3. Requirements Checklist

Inspection Date | **Approved By** | **Notes**

Air Leakage, Component Certification, and Vapor Retarder Requirements

- All joints and penetrations are caulked, gasketed weatherstripped, or otherwise sealed _______ _______
- Windows, doors, and skylights certified as meeting leakage requirements _______ _______
- Compound R-values and U-factors are labeled as certified _______ _______
- Vapor retarders installed (except zones 1-7) _______ _______

Climate Specific Requirements

	Description	Proposed R-Value	Minimum R-Value	Inspection Date	Approved By
Wall Type 1				_______	_______
Wall Type 2				_______	_______
Wall Type 3				_______	_______
Wall Type 4				_______	_______
Roof Type 1				_______	_______
Roof Type 2				_______	_______
Roof Type 3				_______	_______
Floor Type 1				_______	_______
Floor Type 2				_______	_______

	Description	Proposed U Factor	Minimum U-Factor	Inspection Date	Approved By
Window 1				_______	_______
Window 2				_______	_______
Window 3				_______	_______
Skylight 1				_______	_______
Skylight 2				_______	_______

	Exterior Shading?		Proposed SHGC	Maximum SHGC	Inspection Date	Approved By
Window 1	Y/N	PF			_______	_______
Window 2	Y/N	PF			_______	_______
Window 3	Y/N	PF			_______	_______

PF – Projection Factor
Skylights less than 3% of the Total Roof Area ___ % of Roof _______ _______

Statement of Compliance: The proposed building design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building design has been designed to meet the 2000 IECC Envelope Requirements.

________________________________ ________________________________ ___________

Principal Envelope Designer | Signature | Date

Simple Mechanical Compliance Certificate for the IECC®

Required on Project Plans. All Information Must be Filled in

Section 1 Project Information

Project Name____ Permit Number ________________________________

Project Address____ Date ________________

Owner/Agent_____________________________________Telephone__________Checked By___________________

Documentation Author____ Telephone_____________________

Submitted By______________________ Phone Number ______________ Date Submitted:________________

Department Use Only

Section 2 General Information

Building Floor Area:_______

Project Description: New Construction ____ Addition _____ Alteration _____ Unconditioned Shell ________

Section 3. Requirements Checklist

	Inspection Date	Approved By	Notes
Load Calculations			
• Load calculations per 1997 ASHRAE fundamentals	_______	_______	
• Equipment sized to load	_______	_______	
Heating and Cooling System Controls			
• One solid-state setback thermostat with occupant override per zone	_______	_______	
• Air economizer on systems > 90,000 Btu/h or 3,000 cfm	_______	_______	
• Exceptions exempted climate zones, supermarkets, High-efficiency cooling equipment tradeoff			
• Minimum EER___ EER____	_______	_______	
Duct Construction			
• Duct insulation meets minimum R-values	_______	_______	
• Duct in unconditioned spaces R-value _____	_______	_______	
• Ducts outside the building R-value _____	_______	_______	
Hydronic Heating Systems			
• Pipe insulation thickness _____	_______	_______	
• Part load efficiency method (temp reset/variable flow) (circle one)	_______	_______	
Water Heating Systems	_______	_______	
• Heat traps in inlet/outlet fittings	_______	_______	
• Pipe insulation on inlet/outlet pipes ___ in. thickness	_______	_______	
• Recirculation System Yes ____ No _____	_______	_______	
• Pipes insulated ____ in. thickness	_______	_______	
• Automatic time-switch control	_______	_______	
	_______	_______	

Statement of Compliance: The proposed building design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building design has been designed to meet the 2000 IECC Envelope Requirements.

________________________________ ____________________________ ___________

Principal Mechanical Designer Signature Date

Mechanical Compliance Certificate for Complex Systems for the IECC®

Required on Project Plans. All Information Must be Filled in

Section 1 Project Information

Project Name____ Permit Number ________________________________

Project Address____ Date _________________

Owner/Agent______________________________________Telephone___________Checked By____________________

Documentation Author____ Telephone_____________________

Submitted By_____________________ Phone Number ______________ Date Submitted:________________

Department Use Only

Section 2 General Information

Building Floor Area:______

Project Description: New Construction ____ Addition _____ Alteration _____ Unconditioned Shell ________

Section 3. Requirements Checklist

	Inspection Date	Approved By	Notes
Load Calculations			
• Load calculations per 1997 ASHRAE fundamentals -AND-	_______	_______	
• Capacities shown on plans	_______	_______	
Equipment Efficiency			
• Newly purchased equipment covered by mfr. std. OR			
• Meets efficiency requirement in table	_______	_______	
Heating and Cooling System Controls			
• Minimum one temperature control device per zone	_______	_______	
• Minimum thermostat capabilities:			
• Minimum 5-degree deadband	_______	_______	
• Setback/setup capability to 55°F and 85°F	_______	_______	
• 7-day clock, 2-hr occupant override, 10-hr backup	_______	_______	
• Exception: area that operates continuously	_______	_______	
• Heat pump thermostat used with supplemental electric resistant heat	_______	_______	
Outdoor Air Ventilation			
• In accordance with Chapter 4 of the IMC	_______	_______	
• Automatic shut-off dampers on supply and exhaust systems with airflow >3,000 cfm	_______	_______	
Economizers			
• Economizers on systems >90,000 Btu/h or > 3,000 cfm	_______	_______	
Exceptions (circle those that apply)			
• Exempted climate zone	_______	_______	
• Supermarkets	_______	_______	
• High-efficiency cooling equipment tradeoff	_______	_______	
• Minimum EER, EER:______	_______	_______	
• Other____________________________	_______	_______	
Hydronic Systems Control			
• Separate hot and cold water supplies and returns	_______	_______	
• No capability for concurrent hot and chilled water supply to terminals	_______	_______	
• Exception–zones with special humidity requirements	_______	_______	
• Hydronic systems > 600 kBtu/h have (circle one)	_______	_______	
__ reset controls for supply water temperature, OR	_______	_______	
__ mechanical or electrical adjustable-speed pump drives, OR	_______	_______	
__ multiple-stage pumps, OR	_______	_______	
__ other system controls that reduce pump flow by at least 50% based on load (calculations required	_______	_______	

	Inspection Date	Approved By	Notes
Variable Air Volume Fan Control			
• Systems serving more than one zone are VAV	________	________	
Exceptions (circle ones applied)	________	________	
• Special pressurization relationships			
• 75% energy recovery			
• Special humidity requirements			
• Zone supply ≤ 300 cfm and < 10% of total fan supply			
• Where reheated/recooled air < min OSA req.			
• Sequential controls that prevent reheat/recool			
• VAV fans with motors ≥ 25 hp:	________	________	
Exceptions (circle one applied)	________	________	
• Have mech or elec variable speed drive(s), OR			
• Are vane-axial fans with variable pitch blades, OR			
• Have other controls that reduce motor demand to 50%			
• Design kW at 50% design flow (calcs req.)			
• Zone supply ≤ 300 cfm and < 10% of total			
• Controls are capable of resetting supply air temp (SAT by 25% of (SAT – room temp) difference	________ ________	________ ________	
• Single duct VAV terminals are capable of reducing primary air before reheating	________	________	
• Dual duct VAV mixing boxes are installed to minimize mixing			
Duct Construction			
• Duct insulation meets minimum R-values	________	________	
• Duct in unconditioned spaces R-value _____			
• Ducts outside the building R-value _____			
• Ducts sealed			
• Joints and seams on ductwork fastened and sealed per	________	________	
• UL 181A or B (no duct tape as primary sealant)			
• Systems with > 3" wg sealed in accordance with	________	________	
• SMACNA Leakage Class (CL) < 6.0			
Hydronic Heating Systems	________	________	
• Pipe Insulation Thickness _____	________	________	
• Part load efficiency method (temp reset/variable flow) (circle one)			
HVAC System Completion	________	________	
• Balancing devices in accordance with IMC 603.15	________	________	
• Balancing and pressure test connection on all hydronic terminal devices	________	________	
• O & M Manual(s) provided to building owner			

Statement of Compliance: The proposed building design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building design has been designed to meet the 2000 IECC Mechanical Requirements.

______________________________ ________________________ _________

Principal Mechanical Designer Signature Date

Lighting Compliance Certificate for the 2000 IECC®

ALL INFORMATION MUST BE FILLED IN - PRINT CLEARLY

Section 1 - Project Information

Project Name		**Permit #**
Address		**Date**
Owner/Agent	Telephone	**Checked By**
Documentation Author	Telephone	**Date** **For Department Use Only**

Section 2 - General Information

Building Floor Area			
Project Description	☐ New Construction	☐ Addition	☐ Alteration
Method of Lighting Compliance	☐ Entire Building	☐ Tenant Area or Portion of Building	

Section 3 - Requirements Checklist

	Inspection Date	Approved By	Notes
Controls, Switching, and Wiring			
Independent controls for each space (switch/occupancy sensor) Exceptions: security lighting building lobby/retail store/mall	______	______	
Master switch at entry to each hotel/motel guest room	______	______	
Two switches, dimmer, or occupancy sensor in each space providing a uniform illumination pattern Exceptions: the area has only one luminaire an occupant-sensing device controls the area the area is a corridor, storage area, restroom, or lobby	______	______	
Photocell or astronomical time-switch on exterior lights Exception: large covered areas requiring lighting during daylight hours	______	______	
Tandem-wired one-lamp and three-lamp ballasted luminaires Exceptions: electronic high-frequency ballasted luminaires luminaires not on same switch	______	______	
Interior Lighting Total actual watts must be less than or equal to total allowed watts			
Allowed Watts | **Actual Watts** | **Lighting Complies (Y/N)**	______	______	
External Lighting Type(s) of exterior-lighting sources: ☐ fluorescent ☐ metal halide ☐ high-pressure sodium	______	______	
Lighting from electrical service: minimum of 45 lumens per watt Exceptions: specialized signal, directional, and marker ltg. lighting highlighting exterior features of historic building lighting integral to advertising signage safety or security lighting low-voltage landscape lighting	______	______	

Section 4 - Compliance Statement

The proposed lighting design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2000 IECC lighting requirements.

Principal Lighting Designer - Name	**Signature**	**Date**

NOTE: *This form is required on project plans. The Lighting Application Worksheet may be incorporated into the lighting schedule.*

Examination

Instructions and Procedures

1. Study the video training tape and workbook carefully and in full.
2. You may use the *International Energy Conservation Code*® or other literature referenced in this publication to answer the questions.
3. Choose your preferred method: on-line (www.icbo.org under Training) or paper/pencil.
4. You must complete the exam on your own without the help or assistance of others.
5. The questions are final as they appear and no further clarifications will be provided by ICBO.
6. Choose only one answer: the correct or the best possible answer from the choices provided.
7. ICBO will provide a pass/fail report for your exam instantaneously when taken online and within 30 days of receiving your answers when taken in paper/pencil format.
8. Passing scores will receive a certificate, awarding the number of CEUs and/or LUs noted in the suggestions section of the workbook.
9. Failing score reports will be returned to you with a new answer sheet for an exam retake. Please note that each retest will cost $10.
10. You should retain your score reports for your records and for submission to any registration boards that require continuing professional development for license maintenance.
11. Your score reports will be maintained by ICBO for seven years and will be made available only to you or as directed by you (to send to registration board, etc.).
12. Duplicate copies of your score report will be made available for a fee of $15.
13. Our training department may be contacted by mail at the address below, or by phone at (800) 423-6587, x3418.

Answer sheet (on page 43) must be returned to:

International Conference of Building Officials
5360 Workman Mill Road
Whittier, California 90601-2298
Attention: Training Department

Important: Passing scores will receive a certificate, awarding the number of CEUs and/or LUs noted in the suggestions section of the workbook.

Examination for Inspecting for the Commercial Provisions of the IECC

(Note: Please provide all code references)

1. Under the provisions of this code, all materials, equipment and systems shall be installed in accordance with ___________________.

   A. the manufacturer's installation instructions.
   B. the design specifications as submitted by the building architect.
   C. the approval of the building official.
   D. the equipment specifications as provided by the building contractor.

   Ref: ___________________

2. What is the *U*-factor for a non-labeled, double-glazed skylight having a vinyl frame?

   A. 1.47
   B. 0.87
   C. 0.84
   D. 0.57

   Ref: ___________________

3. What is the *U*-factor for a non-labeled, non-glazed steel door with a foam core?

   A. 0.60
   B. 0.54
   C. 0.40
   D. 0.35

   Ref: ___________________

4. Glazing area refers to ______________________________.

   A. a building's total area of glazed fenestration.
   B. the glazed portion of a door when it exceeds 50 percent of the door area.
   C. only the building windows.
   D. total fenestration within a building's envelope.

   Ref: ___________________

5. For a commercial building being built in Climate Zone 7, a vapor retarder________________________.

A. is not required.
B. is not required if it has been determined that moisture and freezing will not damage the construction materials.
C. is not required if approved means to avoid condensation are provided.
D. must be installed on the warm-in-winter side of the thermal insulation.

Ref: ________________

6. In construction where moisture and its freezing will not damage materials, a vapor retarder ________________.

A. is not required.
B. must be an integral part of the thermal insulation.
C must be installed according to manufacturer's instructions.
D. must be installed on the warm-in-winter side of the thermal insulation.

Ref: ________________

7. A building window with a horizontal shading device measuring 8 feet from the vertical surface of the glazing and measuring 16 feet vertically from the underside of an eave to the bottom of a window has a PF of ________________.

A. 0.25
B. 0.5
C. 2
D. 1

Ref: ________________

8. When inspecting for the glazing area in an exterior wall in a commercial building, the following measurements should be verified: ________________.

A. the area of the window unit, only
B. the rough opening for windows and doors with greater than 50 percent glass area
C. the area of the glazed portion of the window or glass door only.
D. the rough opening of the window unit only.

Ref: ________________

9. Air sealing of openings and penetrations in a commercial building envelope ________________.

A. is not required.
B. is required only in Climate Zones 8 through 19.
C. is required.
D. is required only in Climate Zones 1 through 7.

Ref: ________________

10. A duct system for a commercial building includes which of the following?

A. ductwork
B. duct fittings
C. plenums
D. all of the above

Ref: ____________________

11. Heat traps shall be supplied on the supply and discharge piping of a service water heating system with ____________________.

A. return circulation piping systems
B. no piping insulation
C. non circulation systems with no integral heat traps
D. all service water heating systems

Ref: ____________________

12. For commercial buildings, a manual interior lighting control shall be required ____________________.

A. in each building zone.
B. for control of each 500 square feet of building space.
C. in each area enclosed by walls or floor to ceiling partitions.
D. when automatic controls are not used.

Ref: ____________________

13. Which of the following interior building areas are not required to have bi-level light switching?

A. Areas that are used for public meetings.
B. Areas that are controlled by an occupant-sensing device.
C. An enclosed office space.
D. Areas designated as libraries.

Ref: ____________________

EXAMINATION ANSWER SHEET

Inspecting for the Commercial Provisions of the IECC

Circle the correct answer.

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
5.	A	B	C	D
6.	A	B	C	D
7.	A	B	C	D
8.	A	B	C	D
9.	A	B	C	D
10.	A	B	C	D
11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D

Name: ______________________________

Address: ______________________________

Phone Number: ______________________________

AIA Membership Number (if applicable): ______________________________

(only if you would like your passing score reported to the AIA)

Mail answer sheet to:

International Conference of Building Officials
5360 Workman Mill Road
Whittier, California 90601-2298
Attention: Training Department