Connecticut
Building Standard Guidelines
Compliance Manual for High Performance Buildings

February 2011

Prepared For

The Connecticut Office of Policy and Management

by:

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This publication was commissioned and finalized by the Connecticut Office of Policy and Management, in consultation with the Department of Public Works, the Department of Public Safety, the Department of Environmental Protection, and the Institute for Sustainable Energy at Eastern Connecticut State University. It is designed to provide accurate and authoritative information with regard to the subject matter covered. However, although great care has been taken in the compilation and publication of this manual, it is published with the understanding that (1) the publisher and authors make no guarantee that the manual meets all federal, state, and local statutory, regulatory, or other requirements, and (2) the publisher and authors are not engaged in rendering professional advice via this manual or their work and/or affiliation with the State of Connecticut. The publisher and authors cannot be responsible for errors or omissions or any agency's interpretations, applications, and changes of regulations or specifications described in this publication. Use of any provision contained herein is the sole responsibility of the specifier and project owner.

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Introduction

This handbook has been developed to assist state and local building code officials, architects, and contractors in complying with State of Connecticut Regulation Section 16a-38k-1 through 9: The Establishment of High Performance Building Construction Standards for State-Funded Buildings. It contains guidelines and requirements for meeting both mandatory and optional strategies to ensure compliance with the regulation. This handbook was prepared to allow periodic updates as referenced materials are modified and updated.

These regulations were developed by the Connecticut Office of Policy and Management in consultation with the Department of Public Works, the Department of Environmental Protection, the Department of Public Safety, and the Institute for Sustainable Energy at Eastern Connecticut State University. The regulation sets environmental and energy efficiency standards for state-funded facilities that are newly constructed or are undergoing major renovations.

For state agency buildings, this regulation includes twelve mandatory requirements that must be met by all projects. In addition, there are sixty optional strategies, twenty-six of which must be met in order for the project to be in compliance. For schools, the regulation requires buildings to meet the twelve mandatory requirements that state agency buildings must meet **plus** six additional mandatory measures. Schools then must meet twenty-eight of fifty-nine optional strategies.

The regulations were adopted primarily to require state-funded buildings to be built utilizing a high performance building standard equivalent to that of the United States Green Buildings Council (USGBC) Leadership in Energy and Environment Design (LEED) Green Building Rating System™-Silver. This rating system primarily focuses on five areas of concern: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

Complying with these regulations will produce buildings that consume less energy, conserve natural resources, are more comfortable, healthier, and are easier and less costly to maintain.

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State of Connecticut

REGULATION
of

NAME OF AGENCY

Office of Policy and Management

Concerning

SUBJECT MATTER OF REGULATION

The Establishment of High Performance Building Construction Standards for State-Funded Buildings

The Regulations of Connecticut State Agencies are amended by adding sections 16a-38k-1 to 16a-38k-9, inclusive, as follows:

(NEW) Section 16a-38k-1. Definitions

As used in section 16a-38k-1 to section 16a-38k-9, inclusive, of the Regulations of Connecticut State Agencies:

1) "ASHRAE" means the American Society of Heating, Refrigerating, and Air Conditioning Engineers;

2) "Building envelope systems" means the part of the building that represents the barrier between the outdoor and indoor environments, and includes such components as windows, doors, walls, and roofs.

3) "Carpet and Rug Institute" means a trade association that represents manufacturers and suppliers of carpets, rugs, and floor coverings;

4) "Chlorofluorocarbons" or "CFCs" means a class of chemical compounds containing chlorine, fluorine, and carbon that were commonly used as refrigerants and that damage the earth's ozone layer;

5) "Class I Renewable Energy Source" means "Class I Renewable Energy Source" as defined in section 16-1(a)(26) of the Connecticut General Statutes;

6) "Commissioner" means the commissioner of the Department of Public Works;

7) "Commissioning" means the process of verification that the building's systems perform as designed and according to project requirements and construction documents, including assurances that the specified systems are installed properly and adjusted correctly;

8) "Composite wood and agrifiber products" means particleboard, medium density fiberboard, plywood, wheatboard, strawboard, panel substrates, and door cores;

9) "Connecticut State Building Code" means the state building code as adopted under Section 29-252 of the Connecticut General Statutes**;**

10) "Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings" means a reference and support manual prepared to assist building teams to comply with sections 16a-38k-1 to 16a-38k-9 inclusive of the Regulations of Connecticut State Agencies, and available electronically on the Connecticut Office of Policy and Management website;

11) "Energy Star" means a program developed jointly by the United States Department of Energy and the United States Environmental Protection Agency that labels products to designate high levels of energy efficiency;

12) "Forest Stewardship Council" means a not-for profit, international membership-based organization that accredits third-party organizations to certify that forest managers and forest product producers support responsible forest management;

13) Green Globes system" means a green building design and management tool that includes a rating system and guide to encourage the integration of environmentally friendly design into buildings;

14) "Green Label Plus" means an independent testing program developed by the Carpet and Rug Institute to provide assurances that carpet and adhesive products meet stringent criteria for low chemical emissions;

15) "Halons" means a class of organic chemical compounds that contain carbon, fluorine and bromine and may contain chlorine and are destructive to the earth's ozone layer;

16) "Heat island effect" means local air and surface temperatures that are higher than nearby natural areas as a result of heat absorbing surfaces at a site;

17) "Hydrochlorofluorocarbons" or "HCFCs" means a class of chemical compounds containing hydrogen, chlorine, fluorine and carbon that are commonly used as substitute refrigerants to Chlorofluorocarbons because they are less damaging to the earth's ozone layer;

18) "Institute for Sustainable Energy" means the Institute for Sustainable Energy at Eastern Connecticut State University;

19) "Leadership in Energy and Environmental Design" or "LEED" means a rating system developed by the U. S. Green Building Council to encourage

environmental integrity, energy efficiency, healthy work spaces, and sustainable building practices in buildings;

20) "Low emitting and fuel efficient vehicles" means vehicles that are classified as zero emission vehicles by the California Air Resources Board or have achieved a minimum green score of 40 on the American Council for an Energy Efficient Economy annual vehicle rating guide;

21) "Minimum Efficiency Reporting Value" or "MERV" means a number ranging from one to sixteen that indicates the efficiency at which an air filter can remove particles, where one is the least efficient and sixteen is the most efficient at removing particles;

22) "New England Power Pool Generation Information System" or "NEPOOL-GIS" means a system that verifies and manages Renewable Energy Certificates that are the basis for environmental trading and investment incentives in the New England states;

23) "On-site renewable energy" means renewable energy systems located on the building or building site that produce electricity or hot water for use in the building. This includes solar photovoltaic systems, solar hot water systems, wind energy systems, and fuel cell systems;

24) "Pre-consumer recycled content" means that the materials used to make the product were recyclables from within the manufacturing process and never reached consumers;

25) "Preferred parking" means parking spots that are closest to the main entrance of the building, exclusive of handicap designated spaces;

26) "Project manager-facilitator" means whomever the Department of Public Works, Department of Transportation, Office of Legislative Management, the University of Connecticut, or municipality appoints as the lead individual responsible for a particular project;

27) "Post-consumer recycled content" means that the materials used to make a product were already used by a consumer and recycled;

28) "Renewable Energy Credit" or "REC" means a certificate representing one megawatt hour of renewable energy that is physically metered and verified from the generator or the renewable energy project;

29) "School renovation" means "renovation" as defined in section 10-282 of the Connecticut General Statutes;

30) "SDE Commissioner" means the commissioner of the State Department of Education;

31) "Secretary" means the secretary of the Office of Policy and Management;

32) "Solar Heat Gain Coefficient" or "SHGC" means a measure of how well a window blocks heat from sunlight. The SHGC is the fraction of the heat from the sun that enters through a window. It is expressed as a number between 0 and 1. The lower a window's SHGC, the less solar heat it transmits;

33) "Solar Reflectance Index" means a measure of a surface's ability to reflect solar heat, with white being one hundred and black being zero;

34) "State facility" means a building that is owned by the state of Connecticut;

35) "State facility renovation" means an undertaking whereby the designer manipulates the building envelope, electrical systems, mechanical systems, and efficiency of equipment for modification of performance, when costs are two million dollars or more. This includes entire buildings as well as isolated portions of the building;

36) "U. S. Green Building Council" means a membership organization dedicated to shaping the future of sustainable building design through the development of LEED rating system for building performance; and

37) "Volatile organic compound" or "VOC" means a class of chemicals that are emitted as gases from certain solids and liquids and that have short- and long-term adverse health effects.

(NEW) Section 16a-38k-2. Applicability

Sections 16a-35k-1 to 16a-35k-9 apply to:

(a) New construction of a state facility that is projected to cost five million dollars or more, and for which all budgeted project bond funds are allocated by the State Bond Commission on or after January 1, 2008;

(b) State facility renovation that is projected to cost two million dollars or more of which two million dollars or more is state funding, and is approved and funded on or after January 1, 2008;

(c) New construction of public school buildings costing five million dollars or more of which two million dollars or more is state funding, and is authorized by the General Assembly pursuant to chapter 173 on or after January 1, 2009; and

(d) School renovation that is projected to cost two million dollars or more of which two million dollars or more is state funding, and is authorized by the General Assembly pursuant to chapter 173 on or after January 1, 2009.

(NEW) Section 16a-38k-3. Mandatory Building Project Requirements

All building projects pursuant to section 16a-38k-2 of the Regulations of Connecticut State Agencies shall meet the minimum building standards outlined in subsections (a) through (*l*) of this section:

(a) Building commissioning shall be an integral part of the building project. Such commissioning shall be performed by an independent third-party, called a commissioning agent, who shall be certified as a commissioning agent by the Building Commissioning Association or the Association of Energy Engineers, and shall either be a Professional Engineer or have an S-1 license. This individual shall be included in the beginning stages of the building process through a post-occupancy evaluation. The commissioning agent shall not be an employee of the architectural, engineering, or construction firm that implements the project, and shall be hired directly by the state, municipality, or regional school district. For state facility projects, the commissioning agent may be an employee of the Department of Public Works provided such person shall act independently of the other staff
assigned to oversee the design and construction of the project. The commissioning agent shall report all findings and recommendations to the owner of the state facility or the municipal or regional school district. Coordination and oversight of the training of facility management and maintenance personnel on proper equipment operation as well as verification of proper development of systems manuals shall be overseen by the commissioning agent in cooperation with the project manager-facilitator and with the building owner, designer, contractor, and subcontractors who installed the systems. The commissioning process, at minimum, shall include the following energy-related systems: (1) heating, ventilating, air conditioning, and refrigeration systems and associated controls, (2) lighting and day-lighting controls, (3) domestic hot water systems, and (4) renewable energy systems. It is required that the commissioning process also include water using systems and the building envelope systems. **(page 1)**

(b) All building construction projects shall follow an integrated design process to set environmental and building performance goals. This process, at minimum, shall include at least one collaborative session of the design team consisting of the architect, mechanical engineer, electrical engineer, civil engineer, commissioning agent, the project manager-facilitator representing the building owner, and representative(s) of the building tenant state agency or municipality, as applicable, prior to the preparation of contract documentation. The meeting shall include the owner's project requirements, the basis of design, commissioning plan, performance verification documentation, commissioning report, and post commissioning requirements. Prior to the start of the construction phase, at least one collaborative session among the designers, owner, and contractors, including any selected electrical, mechanical, and controls subcontractors shall be held to insure knowledge of design intent, required approval processes, and commissioning procedures. All records of decisions from the collaborative sessions

shall be shared among the design team. The owner of the state facility or the municipal or regional school district shall have final decision making authority. **(page 6)**

(c) The base minimum energy performance for all building projects shall be twenty-one percent better than the most current Connecticut State Building Code or ASHRAE Standard 90.1-2004, whichever is more stringent. Base minimum energy performance shall be determined using approved building modeling software that is identified in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.* **(page 9)**

(d) Energy consuming products installed in the building shall be Energy Star compliant if the product category has an Energy Star specification. **(page 11)**

(e) The project manager-facilitator shall develop an indoor air quality management plan for the construction phase of the project. As part of the plan, the following shall be addressed:

(1) Periodic inspections of materials stored on-site to ensure that all installed or stored absorptive materials are protected from moisture and mold damage. If resting on the ground, spacers shall be provided to allow air to circulate between the ground and the materials. All water-damaged materials shall be removed from the site and disposed of properly.
(2) Surface grades, drainage systems, and heating, ventilating and air conditioning condensate drainage systems shall be designed so as to prevent accumulation of water under, in, or near the building. Irrigation systems shall be designed so as to prevent spraying of the building.
(3) Ductwork shall be sealed from outside elements during transport and storage, and interior surfaces shall be wiped down immediately prior to installation. During installation, open ends of ductwork shall be temporarily sealed and ductwork shall be protected with surface wrapping. No installed ductwork shall contain internal porous insulation materials or lining.
(4) Heating, ventilation, and air conditioning (HVAC) equipment shall be covered and protected from moisture during transportation and on-site storage. For permanently installed air handlers used during construction, use filtration media in air handlers with a Minimum Efficiency Reporting Value (MERV) of ten, except for unit ventilator systems which shall have a minimum MERV of seven. All filtration media shall be replaced immediately prior to building occupancy with media having a MERV rating of equal or greater value to existing media.
(5) Materials that off-gas toxic or potentially toxic fumes shall be pre-conditioned for at least seventy-two hours prior to installation within the building. Such materials shall also be installed
prior to the installation of porous building materials to reduce absorption and adsorption of those toxins by the porous materials. Prior to installation of porous materials and materials vulnerable to mold, the building enclosure shall be watertight.
(6) In the event that any portion of the building is occupied during construction or renovation activities, the Sheet Metal and Air Conditioning Contractor's National

Association (SMACNA) *Indoor Air Quality Guidelines for Occupied Buildings Under Construction* shall be followed. **(page 13)**

(f) Use low-flow fixtures to consume twenty percent less water in aggregate as compared to base levels calculated by meeting the Federal Energy Policy Act of 1992 fixture performance requirements. Calculations shall be based on estimates of occupant usage and shall include the following building fixtures only: showers, urinals, toilets, bathroom sink faucets, and kitchen sink faucets. **(page 15)**

(g) The building or building site shall contain convenient areas to serve as collection points for recyclable materials and shall include an area for the sorting and storage of such materials for pick-up by recyclers. **(page 17)**

(h) All construction shall include a plan for erosion and sediment control, as required by sections 22a-325 through 22a-329 of the Connecticut General Statutes. **(page 18)**

(i) No smoking shall be permitted in any building or portion of a building owned and operated or leased and operated by the state or any political subdivision thereof as mandated by section 19a-342 of the Connecticut General Statutes. All exterior designated smoking areas shall be located at least twenty-five feet away from outdoor air intakes, operable windows, and building entrances. **(page 20)**

(j)A plan for integrated pest management as defined in section 22a-47 of the Connecticut General Statues, shall be established as required under section 22a-66*l* for general pest control in state buildings. Schools shall comply with sections 10-231d and 22a-66*l* of the Connecticut General Statutes. **(page 21)**

(k) Chlorofluorocarbon (CFC)-based refrigerants shall not be utilized for energy systems in new construction. For renovation projects where existing heating, ventilating and air conditioning equipment is reused, a CFC phase-out conversion shall be undertaken. **(page 23)**

(*l*) Buildings shall be designed to meet the minimum ventilation requirements of the current ASHRAE Standard 62.1 using the Ventilation Rate Procedure for mechanical systems. If the current Connecticut State Building Code contains more stringent requirements, it shall be used to meet minimum ventilation requirements. **(page 25)**

(NEW) Section 16a-38k-4. Building Standard Strategies for State Facilities

All building projects as defined in sections 16a-38k-2 (a) and 16a-38k-2 (b) of the Regulations of Connecticut State Agencies shall implement a minimum of twenty-six of the sixty strategies in subsections (a) through (f) of this section.

(a) (Energy efficiency and Renewable Energy- A minimum of one strategy in this subsection is required.

(1) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by three and one-half percent. **(page 26)**
(2) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by seven percent. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (a)(1) of this section. **(page 26)**
(3) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by ten and one-half percent. Selection of this strategy shall count as implementing three strategies since it is inclusive of the strategies listed in subsections (a)(1) and (a)(2) of this section. **(page 26)**
(4) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by fourteen percent. Selection of this strategy shall count as implementing four strategies since it is inclusive of the strategies listed in subsections (a)(1) through (a)(3) of this section. **(page 26)**
(5) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by seventeen and one-half percent. Selection of this strategy shall count as implementing five strategies since it is inclusive of the strategies listed in subsections (a)(1) through (a)(4) of this section. **(page 26)**
(6) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by twenty-one percent. Selection of this strategy shall count as implementing six strategies since it is inclusive of the strategies listed in subsections (a)(1) through (a)(5) of this section. **(page 26)**
(7) The installation of on-site renewable energy shall provide at least three percent of the building energy needs based upon the most recent version of the U. S. Department of Energy Commercial Buildings Energy Consumption survey for estimated electricity usage or by using modeling software that is identified in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.* The facility shall retain ownership of associated renewable energy credits (RECs) for a period of two years. **(page 26)**
(8) Same as in section 16a-38k-4(a)(7) except at least seven percent of the building energy needs are met through on-site renewable energy. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (a)(7) of this section. **(page 26)**
(9) Same as in section 16a-38k-4(a)(7) except at least ten percent of building energy needs are met through on-site renewable energy. Selection of this strategy shall count as implementing three strategies since it is inclusive of the strategies listed in subsections (a)(7) and (a)(8) of this section. **(page 26)**
(10) The facility shall have a two-year contract to purchase at least thirty-five percent of the building's annual electricity consumption from a Class I renewable energy source. Alternately, the purchase may be in the form of New England Power Pool Generation Information System (NEPOOL-GIS) renewable energy credits (RECs); or if procuring RECs outside of the NEPOOL-GIS, the RECs shall be equivalent to Class I renewable resources and certified by a nationally recognized certification organization as identified in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.* Baseline electric usage can be determined using either the most recent

version of the U. S. Department of Energy Commercial Buildings Energy Consumption survey for estimated electricity usage or by using building modeling software that is identified in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings*. RECs purchased to comply with this subsection shall not be purchased from a facility that has installed renewable energy systems for credit under subsections (a)(7) through (a)(9) of this section. **(page 28)**

(11) Develop a measurement and verification plan for energy usage, to cover a period of at least one year after occupancy. **(page 30)**

(b) Indoor Environment -A minimum of two strategies in this subsection are required.

(1) Install permanent indoor air monitoring systems to provide performance feedback on ventilation systems. Such monitoring systems, at minimum, shall include devices to measure temperature, relative humidity, carbon dioxide, and dew point. Carbon dioxide measurement sensors shall measure both interior and exterior levels of CO2. **(page 31)**

(2) Provide increased outdoor ventilation by designing mechanical ventilation systems to exceed the minimum rates required by the current Connecticut State Building Code or the current version of the ASHRAE Standard 62.1, whichever is more stringent, by thirty percent. **(page 31)**

(3) After construction ends and with all interior finishes installed but prior to building occupancy, flush the building continuously for at least ten days with outside air while maintaining an internal temperature between 60°F and 78°F and relative humidity no higher than 60%. Do not “bake out” the building by increasing the temperature of the space. Alternatively, use the following strategy: Flush out each space separately until 3,500 cubic feet of outside air per square foot of floor space has been delivered to that space. The space shall then be ventilated at the rate of 0.3 cubic feet per minute per square foot of floor space or the design minimum outside air rate, whichever is greater. This shall be performed for a minimum of three hours prior to occupancy and then during occupancy until a total of 14,000 cubic feet of outside air per square foot of floor area has been delivered to that space. **(page 32)**

(4) Adhesives and sealants used in the interior of the building shall be certified for low emissions of volatile organic compounds (VOCs) using specifications or certification programs listed in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.* **(page 32)**

(5) Paints and coatings used in the interior of the building shall be certified for low emissions of volatile organic compounds (VOCs) using specifications or certification programs listed in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.*6) All carpet, carpet adhesive products and carpet cushion installed in the building interior shall meet current testing and product requirements of the Carpet and Rug Institute’s Green Label Plus program. **(page 32)**

(6) All carpet, carpet adhesive products and carpet cushion installed in the building interior shall meet current testing and product requirements of the Carpet and Rug Institute's Green Label Plus program. **(page 33)**

(7) All composite wood and agrifiber products used within the shell of the building shall meet the testing and product requirements of the California Department of Health Services *Standard Practice for the Testing of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers,* including 2004 Addenda. **(page 33)**

(8) To protect building occupants from potentially hazardous particulates and pollutants, building design shall control entry of pollutants and excess moisture into buildings and later cross-contamination of regularly occupied areas at all entries directly connecting to the outdoors through the use of permanent entryway systems to capture, dirt, particulates, and moisture. Such entryway systems shall be a minimum of six feet long and may be permanently installed grates, grills, or slotted systems that allow for cleaning underneath. Outside air intakes shall be located a minimum of twenty-five feet from any hazard or noxious contaminants such as vents, chimneys, plumbing vents, exhaust fans, cooling towers, street alleys, parking lots, loading docks, dumpster areas, or any area where vehicle idling occurs. If locating an air intake within twenty-five feet of a contaminant source is unavoidable, the intake must be located a minimum of ten feet horizontal distance and two feet lower than the contaminant source. **(page 33)**

(9) Allow for individual lighting control for ninety percent or more of the building occupants to allow for adjustments to suit individual tasks and preferences and provide lighting system controllability for all shared multi-occupant spaces to enable lighting adjustment that meets group needs and preferences. **(page 34)**

(10) Using conditions for thermal comfort described in the current version of the ASHRAE Standard 55, allow for individual thermal comfort control for fifty percent or more of the building occupants to allow for adjustments to suit individual tasks and preferences and provide thermal system comfort controllability for all shared multi-occupant spaces to enable adjustment that meets group needs and preferences. **(page 34)**

(11) Building facility personnel, under direction of the building owner, shall administer an anonymous survey for building occupants within the first twelve months after initial occupancy to assess occupant satisfaction and implement corrective actions for recurrent issues. At minimum, the survey shall cover thermal building comfort, lighting, security issues, indoor air quality, functionality of space, and acoustics. If greater than 20% of the respondents express dissatisfaction with any specific issue, the building owner shall prepare a plan for remedial action. **(page 34)**

(12) Demonstrate through computer software simulations or through recording of indoor light measurements that a minimum illumination level of twenty-five foot-candles has been achieved from daylight in at least seventy-five percent of all regularly occupied areas. **(page 34)**

(13) There shall be a direct line of sight to the outdoor environment via window glazing between two and one-half to seven and one half feet above the finished floor for seventy percent of all regularly occupied areas. **(page 35)**

(13) Where chemical use occurs, including housekeeping areas, chemical storage and mixing areas, and copy/print rooms, use dedicated exhaust to ventilate the space at a minimum of 0.5 cubic feet per minute per square foot with adequate make-up air. No recirculation is permitted and such spaces shall have a negative air pressure of at least five pascal (.02 inches of water gauge) to a minimum of one pascal (0.004 inches of water gauge) when the doors are closed. **(page 35)**

(c) Water efficiency- A minimum of one strategy in this subsection is required.

(1) Same as in section 16a-38k-3(f), except that the conserving strategies use thirty percent less water in aggregate. **(page 36)**
(2) Reduce by fifty percent the amount of water required for landscaping from a modeled, mid-summer baseline usage case. Reductions may be attributed to the use of captured rainwater, recycled waste (grey) water, efficiency of irrigation strategies, and use of drought resistant plant species. This strategy only applies to renovation projects. **(page 36)**
(3) Use landscaping that does not require a permanent irrigation system or uses non-potable water for irrigation. Any system installed for irrigation using potable water shall only be utilized for plant establishment and be removed prior to one year of building occupancy. **(page 36)**
(4) Reduce potable water use by half through water conserving fixtures and/or use of non-potable water using methodologies stated in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.* This strategy only applies to renovation projects. **(pages 15 and 36)**

(d) Recycling, Reuse, and Sustainability- A minimum of two strategies in this subsection are required.

(1) Retain at least seventy-five percent, by surface area, of an existing building structure, including structural floor and roof decking, exterior framing, and envelope surface, but excluding window assemblies and non-structural roofing material. This strategy only applies to renovation projects. **(page 38)**
(2) Same as in section 16a-38k-4(d)(1), except that a total of ninety-five percent of the building structure is retained. This strategy only applies to renovation projects. This strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(1) of this section. **(page 38)**
(3) Use existing non-structural elements such as interior walls, doors, floor coverings and ceiling systems in at least half (by square footage) of the completed building. This strategy only applies to renovation projects. **(page 38)**
(4) Recycle or salvage at least half of non-hazardous construction and demolition debris. **(page 38)**
(5) Same as in section 16a-38k-4(d)(4), except that a total of seventy-five percent of non-hazardous construction and demolition debris is recycled or salvaged. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(4) of this section. **(page 38)**

(6) Use five percent of refurbished, salvaged, or reused materials, based on cost of the total value of materials on the project. Only permanently installed materials can by used in calculations. **(page 38)**

(7) Same as in section 16a-38k-4 (d)(6), except that a total of ten percent of refurbished, salvaged, or reused materials, based on cost of the total value of materials on the project shall be used. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(6) of this section. **(page 38)**

(8) Use materials where the weighted average of recycled materials content is ten percent, based on cost, of the total value of the materials in the project. Recycled content value of a material assembly shall be determined by weight. The weighted average shall be determined using the following formula:
Weighted average of recycled materials equals the percentage of post consumer content plus one-half the percentage of pre-consumer content. **(page 39)**

(9) Same as section 16a-38k-4(d)(8), except that the weighted average of recycled materials shall constitute at least twenty percent , based on cost, of the total value of the materials in the project. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(8) of this section. **(page 39)**

(10) Use a minimum of ten percent of building materials extracted or manufactured within a five-hundred mile radius of the building site. **(page 39)**

(11) Same as in section 16a-38k-4(d)(10), except that a minimum of twenty percent of building materials extracted or manufactured within a five-hundred mile radius of the building site shall be used. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(10) of this section. **(page 39)**

(12) Use building materials and products that are made from plants harvested in a ten-year or shorter cycle. Two and one-half percent of the total value of building materials and products, based on costs, must be used in the project. **(page 39)**

(13) At least half of permanently installed wood and wood-based products shall be certified in accordance with the current Forest Stewardship Council (FSC) principles and criteria. **(page 40)**

(e) Site Selection and Development- A minimum of two strategies in this subsection are required.

(1) Construct or renovate the building on a previously developed site and within one-half mile of a residential zone/neighborhood with an average density of ten units per acre net and within one half mile of a minimum of ten basic services as described in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings* and with pedestrian access between the building and the services. **(page 41)**

(2) Develop on a site that is defined as a brownfield by a local, state, or federal government agency. **(page 41)**

(3) Select a site that has access to public transportation. Public transportation is considered accessible if the site is located within one-third of a mile to an existing

commuter rail station or located within one quarter mile of a public commuter bus line. **(page 42)**

(4) Encourage bicycle transportation by providing secure bicycle racks or storage within five-hundred feet of a building entrance for a minimum of five percent of building users at peak times and shower and changing facilities must be provided in the building or within five-hundred feet of the building. For residential buildings, covered storage facilities shall be provided for securing bicycles for a minimum of fifteen percent of building occupants. **(page 42)**

(5) Encourage the use of low-emitting and fuel efficient vehicles by providing preferred parking for low-emitting and fuel efficient vehicles for five percent of the total parking capacity at the site. **(page 42)**

(6) Reduce pollution from single occupancy vehicle use by sizing parking capacity to meet, but not exceed minimum local zoning requirements; provide designated preferred parking for carpools or vanpools for five percent of the total provided parking spaces; and provide infrastructure and support programs to facilitate shared vehicle usage such as ride sharing bulletin boards and shuttle services to mass transit. **(page 42)**

(7) Protect existing natural areas or restore damaged areas to promote biodiversity. Any site disturbances shall be limited to no more than forty feet beyond the building perimeter; ten feet beyond surface walkways, patios, surface parking and utilities less than twelve inches in diameter; fifteen feet beyond primary roadway curbs and main utility branch trenches; and twenty-five feet beyond constructed areas with permeable surfaces, such as playing fields, that require additional staging areas in order to limit compaction in the constructed area. For previously developed or graded sites, restore or protect to a minimum of fifty percent of the site area, excluding the building footprint, to plant species indigenous to the locality or to cultivars of native plants adapted to the local climate conditions and not considered invasive species or noxious weeds. Except for playing fields and picnic areas, minimize lawn areas to less than ten percent of the building site landscape. **(page 43)**

(8) Maximize open space at the site. Provide vegetated open space within the project boundary to exceed the local zoning's open space requirement by twenty-five percent; where there is no local zoning requirement, provide vegetated open space adjacent to the building that, at minimum, is equal to the building footprint. **(page 43)**

(9) Design the site to minimize storm water runoff by implementing a storm water management plan that results in a twenty-five percent reduction in peak run-off rates for a two-year, twenty-four hour storm design from pre-construction to developed conditions; and implement a storm water management plan that results in a twenty-five percent decrease in run-off volume of storm water runoff from the one hundred-year, twenty-four hour storm design from existing to developed conditions. **(page 43)**

(10) Design the site to minimize pollutants in storm water runoff by implementing a storm water management plan that reduces impervious cover, promotes infiltration, redirects water to pervious areas or storage reservoirs that treats storm water runoff from ninety percent of the average annual rainfall. **(page 44)**

(11) Reduce heat island effect at the site by utilizing any combination of the use of native shade species, paving materials with a solar reflectance index of at least twenty-nine, and/or an open grid pavement system for fifty percent or more of the site parking, sidewalk and road areas; or place at least fifty percent of parking spaces under a covering, such as the a deck, a roof, underground or the building itself. Any roof used to cover parking spaces must have a solar reflectance index of at least twenty-nine. **(page 44)**

(12) Reduce heat island effect through roofing selection by either installing native vegetation on at least fifty percent of the roof area or by using a roofing material that has a solar reflectance index equal to or greater than the values in the following table on at least seventy-five percent of the roof surface **(page 44)**:

Roof Type	**Slope**	**Solar Reflectance Index**
Low-Sloped Roof	**≤ 2:12**	**78**
Steep-Sloped Roof	**> 2:12**	**29**

(13) Reduce light pollution from the site. In addition to requirements mandated in Section 4b-16 of the Connecticut General Statutes, automatic controls to turn off lights during non-business hours shall be installed on all non-emergency interior lighting. Manual override capability may be provided for after hours use. Exterior lighting shall be provided only in areas where lighting is required for safety and comfort. Light fixtures shall not be installed where the main purpose is to light building facades or landscape features. Exterior building-mounted lighting fixtures that are only needed during building operation shall be controlled by a time-clock with an easily accessible manual control. Lighting of flags, signs, and monuments shall be limited to fifty watts per fixture and shall incorporate shielding devices to minimize light pollution. No more than two fixtures may be used for each flag, sign or monument. **(page 44)**

(14) Building orientation shall be such that the east/west glazing exposure is minimized. South windows shall have an external overhang to entirely shade adjacent windows during the summer solstice or shall utilize glazing with a solar heat gain coefficient of less than or equal to 0.4. Shading mechanisms or glazing with a solar heat gain coefficient less than or equal to 0.4 shall be installed at eastern and western exposure windows to minimize solar heat gain early and late in the day respectively. **(page 45)**

(15) Buildings, roads, parking areas, sidewalks, or other impervious surfaces shall not be built in any area that is inconsistent with the state plan of conservation and development. **(page 45)**

(f) Operations and Procedures/Innovation – No minimum number of strategies are required for this subsection.

(1) Do not install fire suppression systems that contain chlorofluorocarbons (CFCs), hydro chlorofluorocarbon (HCFCs) or halons. Select refrigerants and heating, ventilating, air conditioning, and refrigeration (HVAC&R) systems that minimize

or eliminate compounds contributing to ozone layer depletion and global warming. If refrigerants are used, the mechanical room shall have leak detection equipment installed. **(page 48)**

(2) Utilize innovative high performance features or technologies that exceed any existing mandatory requirement as specified in Section 16a-38k-3 or optional measure within Section 16a-38k-4. **(page 49)**

(3) In settings where a central plant provides energy to multiple buildings or in cases where multiple buildings are fed from the same fuel source, new construction or major renovation shall include metering and other such equipment necessary to evaluate energy and water consumption. **(page 49)**

(NEW) Section 16a-38k-5. Additional Mandatory Building Project Requirements for Schools.

In addition to complying with the requirements set forth in Section16a-38k-3 of the Regulations of Connecticut State Agencies, all building projects as defined in sections 16a-38k-2(c) and 16a-38k-2(d) of the Regulations of Connecticut State Agencies shall meet the following mandatory requirements.

(a) All classrooms, including art rooms, music rooms, science rooms, computer rooms, and special needs, remedial and library space shall meet the acoustical standards as required under section 10-285g of the Connecticut General Statutes. **(page 50)**

(b) Outside air intakes shall be located a minimum of twenty-five feet from any hazard or noxious contaminants such as vents, chimneys, plumbing vents, exhaust fans, cooling towers, street alleys, parking lots, loading docks, dumpster areas, bus loops, or any area where vehicle idling occurs. If locating an air intake within twenty-five feet of a contaminant source is unavoidable, the intake must be located a minimum of ten feet horizontal distance and two feet lower than the contaminant source. **(page 51)**

(c) Only electronic ignitions shall be specified for gas-fired water heaters, boilers, furnaces, air handling units, and stovetops/ovens. **(page 52)**

(d) The following materials shall be certified for low emissions of volatile organic compounds (VOCs) using specifications or certification programs listed in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings*:

(1) 50% of adhesives and sealants used in the interior of the building;
(2) Acoustic ceiling tiles and wall panels;
(3) Interior paints;
(4) Wall coverings;
(5) Carpet systems and associated adhesives;
(6) Composite and solid wood flooring;
(7) Resilient flooring and associated adhesives. **(page 53)**

(e) The town or regional board of education and the building committee of such town or district, shall provide for a Phase I environmental site assessment in accordance with

the American Society for Testing and Materials Standard #1527, Standard Practice for Environmental Site Assessments: Phase I Site Assessment Process, or similar subsequent standards, as required pursuant to Section 10-291 of the Connecticut General Statutes. If a town, regional board of education or the building committee of such town or district suspect contamination, a Phase II Environmental Site Assessment shall be undertaken as described in American Society for Testing and Materials Standard E1903-97 or similar subsequent standards. Any contamination found shall be remedied. **(page 54)**

(f) Prior to substantial completion of the building, vacuum all carpeted and soft surfaces with a high-efficiency particulate arrestor (HEPA) vacuum. For phased or occupied renovations, HEPA vacuum the carpet daily in occupied areas. **(page 56)**

(NEW) Section 16a-38k-6. Building Standard Strategies for Schools.

All building projects as defined in sections 16a-38k-2(c) and 16a-38k-2(d) of the Regulations of Connecticut State Agencies shall implement a minimum of twenty-eight of the fifty-nine strategies in subsections (a) through (f) of this section:

(a) Energy efficiency and Renewable Energy- A minimum of one strategy in this subsection is required.
  (1) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by three and one-half percent. **(page 57)**
  (2) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by seven percent. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (a)(1) of this section. **(page 57)**
  (3) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by ten and one-half percent. Selection of this strategy shall count as implementing three strategies since it is inclusive of the strategies listed in subsections (a) (1) and (a)(2) of this section. **(page 57)**
  (4) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by fourteen percent. Selection of this strategy shall count as implementing four strategies since it is inclusive of the strategies listed in subsections (a)(1) through (a)(3) of this section. **(page 57)**
  (5) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by seventeen and one-half percent. Selection of this strategy shall count as implementing five strategies since it is inclusive of the strategies listed in subsections (a)(1) through (a)(4) of this section. **(page 57)**
  (6) Same as in section 16a-38k-3(c) except that the percentage improvement over base is increased by twenty-one percent. Selection of this strategy shall count as implementing six strategies since it is inclusive of the strategies listed in subsections (a)(1) through (a)(5) of this section. **(page 57)**
  (7) The installation of on-site renewable energy shall provide at least three percent of the building energy needs based upon the most recent version of the U. S. Department of Energy Commercial Buildings Energy Consumption survey for

estimated electricity usage or by using modeling software that is identified in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings*. **(page 57)**

(8) Same as in section 16a-38k-6(a)(7) except at least seven percent of the building energy needs are met through on-site renewable energy. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (a)(7) of this section. **(page 57)**

(9) Same as in section 16a-38k-6(a)(7) except at least ten percent of building energy needs are met through on-site renewable energy. Selection of this strategy shall count as implementing three strategies since it is inclusive of strategies listed in subsections (a)(7) and (a)(8) of this section. **(page 57)**

(10) The facility shall have a two-year contract to purchase at least thirty-five percent of the building's annual electricity consumption from a Class I renewable energy source. Alternately, the purchase may be in the form of New England Power Pool Generation Information System (NEPOOL-GIS) renewable energy credits (RECs); or if procuring RECs outside of the NEPOOL-GIS, the RECs shall be equivalent to Class I renewable resources and certified by a nationally recognized certification organization as identified in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.* Baseline electric usage can be determined using either the most recent version of the U. S. Department of Energy Commercial Buildings Energy Consumption survey for estimated electricity usage or by using building modeling software that is identified in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.* **(page 59)**

(11) Develop a measurement and verification plan for energy usage, to cover a period of at least one year after occupancy. **(page 61)**

(b) Indoor Environment- A minimum of two strategies in this subsection are required.

(1) Install permanent indoor air monitoring systems to provide performance feedback on ventilation systems. Such monitoring systems, at minimum, shall include devices to measure temperature, relative humidity, carbon dioxide, and dew point. Carbon dioxide measurement sensors shall measure both interior and exterior levels of CO2. **(page 62)**

(2) Provide increased outdoor ventilation by designing mechanical ventilation systems to exceed the minimum rates required by the current Connecticut State Building Code or the current version of the ASHRAE Standard 62.1, whichever is more stringent, by thirty percent. **(page 62)**

(3) After construction ends and with all interior finishes installed but prior to building occupancy, flush the building continuously for at least ten days with outside air while maintaining an internal temperature between 60°F and 78°F and relative humidity no higher than 60%. Do not "bake out" the building by increasing the temperature of the space. Alternatively, use the following strategy: Flush out each space separately until 3,500 cubic feet of outside air per square foot of floor space has been delivered to that space. The space shall then be ventilated at the rate of 0.3 cubic feet per minute per square foot of floor space or the design minimum outside air rate, whichever is greater. This shall be performed for a

minimum of three hours prior to occupancy and then during occupancy until a total of 14,000 cubic feet of outside air per square foot of floor area has been delivered to that space. **(page 62)**

(4) All composite wood and agrifiber products used within the shell of the building shall meet the testing and product requirements of the California Department of Health Services *Standard Practice for the Testing of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers,* including 2004 Addenda. **(page 63)**

(5) For administrative offices and other regularly occupied spaces, allow for individual lighting control for ninety percent or more of the building occupants in workspaces to allow for adjustments to suit individual tasks and preferences. For classroom and core learning spaces, with the exception of chemistry laboratories, art and music rooms, shops, and gyms, install two modes of illumination: general illumination and audio visual illumination. General illumination mode shall achieve desk level illumination of 30-50 foot-candles; audio visual mode shall achieve a desk level illumination of 10 to 20 foot-candles while limiting vertical illumination at a projection screen of no more than seven foot-candles. All lighting fixtures shall include glare control features. **(page 63)**

(6) Using the current version of the ASHRAE Standard 55, allow for individual thermal comfort control in administrative areas for fifty percent or more of the building occupants to allow for adjustments to suit individual tasks and preferences and provide thermal system comfort controllability for all shared multi-occupant spaces such as classrooms, auditoriums, and gyms to enable adjustment that meets group needs and preferences. **(page 64)**

(7) Building facility personnel, under direction of the building owner, shall administer an anonymous survey for building occupants within the first twelve months after initial occupancy to assess occupant satisfaction and implement corrective actions for recurrent issues. At minimum, the survey shall cover thermal building comfort, lighting, security issues, indoor air quality, functionality of space, and acoustics. If greater than 20% of the respondents express dissatisfaction with any specific issue, the building owner shall prepare a plan for remedial action. **(page 64)**

(8) Demonstrate through computer software simulations or through recording of indoor light measurements that a minimum illumination level of twenty-five foot-candles has been achieved from daylight in at least seventy-five percent of all regularly occupied areas. **(page 64)**

(9) There shall be a direct line of sight to the outdoor environment via window glazing between two and one-half to seven and one half feet above the finished floor for seventy percent of all regularly occupied areas. **(page 64)**

(10) To prevent mold, heating, ventilating and air conditioning systems (HVAC) shall be designed to limit space relative humidity to 60% or less during load conditions whether the building is occupied or non-occupied; an ongoing indoor air quality management plan shall be implemented as required under section 10-220 of the Connecticut General Statutes, using the U. S. Environmental Protection Agency's (EPA) Indoor Air Quality *Tools for Schools* Program; and the criteria of sections

16a-38k-6(b)(6) and 16a-38k-6(b)(7) of the Regulations of Connecticut State Agencies shall be met. **(page 64)**

(11) Student and teacher classroom chairs, desks, and tables manufactured, refurbished or refinished within one year prior to building occupancy and used within the building interior shall be certified for low chemical emissions by the certifying organization listed in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings*. **(page 65)**

(12) Where chemical use occurs, including housekeeping areas, chemical mixing areas, photo labs, science labs, art rooms, and copy/print rooms, use dedicated exhaust to ventilate the space at a minimum of 0.5 cubic feet per minute per square foot with adequate make-up air. No recirculation is permitted and such spaces shall have a negative air pressure of at least five pascal (.02 inches of water gauge) to a minimum of one pascal (0.004 inches of water gauge) when the doors are closed. **(page 65)**

(13) Building design shall control entry of pollutants and excess moisture into buildings and later cross-contamination of regularly occupied areas at all high volume entryways and those adjacent to playing fields and locker rooms through the use of three-part walk-off systems and the proper placement of outside air intakes. Walk-off systems shall include a grate or grill outside the entryway for removing dirt and snow, a drop through mat system within the vestibule, and a fifteen foot interior walk-off mat. **(page 65)**

(c) Water efficiency- A minimum of one strategy in this subsection is required.

(1) Same as in section 16a-38k-3(f), except that the conserving strategies use thirty percent less water in aggregate. **(page 67)**

(2) Reduce by fifty percent the amount of water required for landscaping from a modeled, mid-summer baseline usage case. Reductions may be attributed to the use of captured rainwater, recycled waste (grey) water, efficiency of irrigation strategies, and use of drought resistant plant species. This strategy only applies to renovation projects. **(page 67)**

(3) Use landscaping that does not require a permanent irrigation system or uses non-potable water for irrigation. Any system installed for irrigation using potable water shall only be utilized for plant establishment and be removed prior to one year of building occupancy. **(page 67)**

(4) Reduce potable water use by half through water conserving fixtures and/or use of non-potable water using methodologies stated in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.* This strategy only applies to renovation projects. **(pages 15 & 67)**

(d) Recycling, Reuse, and Sustainability-A minimum of two strategies in this subsection are required.

(1) Retain at least seventy-five percent, by surface area, of an existing building structure, including structural floor and roof decking, exterior framing, and

envelope surface, but excluding window assemblies and non-structural roofing material. This strategy only applies to renovation projects. **(page 69)**

(2) Same as section 16a-38k-6(d)(1), except that a total of ninety-five percent of the building structure is retained. This strategy only applies to renovation projects. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d) (1) of this section. **(page 69)**

(3) Use existing non-structural elements such as interior walls, doors, floor coverings and ceiling systems in at least half (by square footage) of the completed building. This strategy only applies to renovation projects. **(page 69)**

(4) Recycle or salvage at least half of non-hazardous construction and demolition debris. **(page 69)**

(5) Same as section 16a-38k-6(d)(4), except that a total of seventy-five percent of non-hazardous construction and demolition debris is recycled or salvaged. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(4) of this section. **(page 69)**

(6) Use five percent of refurbished, salvaged, or reused materials, based on cost of the total value of materials on the project. Only permanently installed materials can by used in calculations. **(page 69)**

(7) Same as section 16a-38k-6(d)(6), except that a total of ten percent of refurbished, salvaged, or reused materials, based on cost of the total value of materials on the project shall be used. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(6) of this section. **(page 69)**

(8) Use materials where the weighted average of recycled materials content is ten percent, based on cost, of the total value of the materials in the project. Recycled content value of a material assembly shall be determined by weight. The weighted average shall be determined using the following formula:
Weighted average of recycled materials equals the percentage of post consumer content plus one-half the percentage of pre-consumer content. **(page 70)**

(9) Same as section 16a-38k-6(d)(8), except that the weighted average of recycled materials shall constitute at least twenty percent , based on cost, of the total value of the materials in the project. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(8) of this section. **(page 70)**

(10) Use a minimum of ten percent of building materials extracted or manufactured within a five-hundred mile radius of the building site. **(page 70)**

(11) Same as in section 16a-38k-6(d)(10), except that a minimum of twenty percent of building materials extracted or manufactured within a five-hundred mile radius of the building site shall be used. Selection of this strategy shall count as implementing two strategies since it is inclusive of the strategy listed in subsection (d)(10) of this section. **(page 70)**

(12) Use building materials and products that are made from plants harvested in a ten-year or shorter cycle. Two and one-half percent of the total value of building materials and products, based on costs, must be used in the project. **(page 70)**

(13) At least half of permanently installed wood and wood-based products shall be certified in accordance with the current Forest Stewardship Council (FSC) principles and criteria. **(page 71)**

(e) Site Selection and Development- A minimum of two strategies in this subsection are required.

(1) Construct or renovate the building on a previously developed site and within one-half mile of a residential zone/neighborhood with an average density of ten units per acre net and within one half mile of a minimum of ten basic services as described in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings* and with pedestrian access between the building and the services. **(page 72)**

(2) Select a site that has access to public transportation. Public transportation is considered accessible if the site is located within one-third of a mile to an existing commuter rail station or located within one quarter mile of a public commuter bus line. **(page 72)**

(3) Encourage bicycle transportation by providing secure bicycle racks or storage within five-hundred feet of a building entrance for a minimum of five percent of building users at peak times and shower and changing facilities must be provided in the building or within five-hundred feet of the building. **(page 73)**

(4) Encourage the use of low-emitting and fuel efficient vehicles by providing preferred parking for low-emitting and fuel efficient vehicles for five percent of the total parking capacity at the site. **(page 73)**

(5) Reduce pollution from single occupancy vehicle use by sizing parking capacity to meet, but not exceed minimum local zoning requirements; provide designated preferred parking for carpools or vanpools for five percent of the total provided parking spaces; and provide infrastructure and support programs to facilitate shared vehicle usage such as ride sharing bulletin boards and shuttle services to mass transit. **(page 73)**

(6) Protect existing natural areas or restore damaged areas to promote biodiversity. Any site disturbances shall be limited to no more than forty feet beyond the building perimeter; ten feet beyond surface walkways, patios, surface parking and utilities less than twelve inches in diameter; fifteen feet beyond primary roadway curbs and main utility branch trenches; and twenty-five feet beyond constructed areas with permeable surfaces, such as playing fields, that
require additional staging areas in order to limit compaction in the constructed area. For previously developed or graded sites, restore or protect to a minimum of fifty percent of the site area, excluding the building footprint, to plant species indigenous to the locality or to cultivars of native plants adapted to the local climate conditions and not considered invasive species or noxious weeds. Except for playing fields and picnic areas, minimize lawn areas to less than ten percent of the building site landscape. **(page 73)**

(7) Maximize open space at the site. Provide vegetated open space within the project boundary to exceed the local zoning's open space requirement by twenty-five percent; where there is no local zoning requirement, provide vegetated open space

adjacent to the building that, at minimum, is equal to the building footprint. **(page 74)**

(8) Design the site to minimize storm water runoff by implementing a storm water management plan that results in a twenty-five percent reduction in peak run-off rates for a two-year, twenty-four hour storm design from pre-construction to developed conditions; and implement a storm water management plan that results in a twenty-five percent decrease in run-off volume of storm water runoff from the one hundred-year, twenty-four hour storm design from existing to developed conditions. **(page 74)**

(9) Design the site to minimize pollutants in storm water runoff by implementing a storm water management plan that reduces impervious cover, promotes infiltration, and redirects water to pervious areas or storage reservoirs that treats storm water runoff from ninety percent of the average annual rainfall. **(page 74)**

(10) Reduce heat island effect at the site by utilizing any combination of the use of native shade species, paving materials with a solar reflectance index of at least twenty-nine, and/or an open grid pavement system for fifty percent or more of the site parking, sidewalk and road areas; or place at least fifty percent of parking spaces under a covering, such as the a deck, a roof, underground or the building itself. Any roof used to cover parking spaces must have a solar reflectance index of at least twenty-nine. **(page 74)**

(11) Reduce heat island effect through roofing selection by either installing native vegetation on at least fifty percent of the roof area or by using a roofing material that has a solar reflectance index equal to or greater than the values in the following table on at least seventy-five percent of the roof surface **(page 74)**:

Roof Type	**Slope**	**Solar Reflectance Index**
Low-Sloped Roof	**≤ 2:12**	**78**
Steep-Sloped Roof	**> 2:12**	**29**

(12) Reduce light pollution from the site. In addition to requirements mandated in Section 4b-16 of the Connecticut General Statutes, automatic controls to turn off lights during non-business hours shall be installed on all non-emergency interior lighting. Manual override capability may be provided for after hours use. Exterior lighting shall be provided only in areas where lighting is required for safety and comfort. Light fixtures shall not be installed where the main purpose is to light building facades or landscape features. Exterior building-mounted lighting fixtures that are only needed during building operation shall be controlled by a time-clock with an easily accessible manual control. Lighting of flags, signs, and monuments shall be limited to fifty watts per fixture and shall incorporate shielding devices to minimize light pollution. No more than two fixtures may be used for each flag, sign or monument. Sports field lighting shall be controlled automatically for shut-off no later than eleven PM, with manual override to prevent disruption of school-sponsored events. **(page 75)**

(13) Building orientation shall be such that the east/west glazing exposure is minimized. South windows shall have an external overhang to entirely shade

adjacent windows during the summer solstice or shall utilize glazing with a solar heat gain coefficient of less than or equal to 0.4. Shading mechanisms or glazing with a solar heat gain coefficient less than or equal to 0.4 shall be installed at eastern and western exposure windows to minimize solar heat gain early and late in the day respectively. **(page 75)**

(14) Buildings shall not be constructed on land that is lower than five feet above the elevation of the 100 year flood as defined by the Federal Emergency Management Agency or its successor agency; and buildings, roads, parking areas, sidewalks, or other impervious surfaces shall not be built in any area that is inconsistent with the applicable municipal plan of conservation and development prepared in accordance with section 8-23 of the Connecticut General Statutes. **(page 76)**

(15) The school building shall be sited on land away from sources of unreasonable excess noise, such as highways, airport flight paths, and areas that are subject to unreasonable noise from agricultural or industrial equipment use. **(page 76)**

(f) Operations and Procedures/Innovation – No minimum number of strategys are required for this subsection.

(1) Do not install fire suppression systems that contain chlorofluorocarbons (CFCs), hydro chlorofluorocarbon (HCFCs) or halons. Select refrigerants and heating, ventilating, air conditioning, and refrigeration (HVAC&R) systems that minimize or eliminate compounds contributing to ozone layer depletion and global warming. If refrigerants are used, the mechanical room shall have leak detection equipment installed. **(page 78)**

(2) Utilize innovative high performance features or technologies that exceed any existing mandatory requirements as specified in sections 16a-38k-3 and 16a-38k-5 or optional measures within Section 16a-38k-6. **(page 78)**

(3) Integrate the sustainable features of the school building into the educational curriculum within the first full year of school operation. **(page 78)**

(NEW) Section 16a-38k-7 Alternative Strategies to Section 16a-38k-4 of the Regulations of Connecticut State Agencies or Section 16a-38k-6 of the Regulations of Connecticut State Agencies. (page 80)

(a) As an alternate to meeting the criteria in section 16a-38k-4 of the Regulations of Connecticut State Agencies, a project as defined by sections 16a-38k-2(a) and 16a-38k-2(b) of the Regulations of Connecticut State Agencies-may meet the requirements under section 16a-38k-4 of the Regulations of Connecticut State Agencies by receiving a Leadership in Energy and Environmental Design (LEED) Silver level certification from the United States Green Building Council, or by receiving a Two-Globe rating from the Green Globe system self certification program, providing that the project includes all mandatory requirements within sections 16a-38k-3 and 16a-38k-8 of the Regulations of Connecticut State Agencies.

(b) As an alternate to meeting the criteria in section 16a-38k-6 of the Regulations of Connecticut State Agencies, a project as defined by sections 16a-38k-2(c) and 16a-38k-2(d) of the Regulations of Connecticut State Agencies may meet the requirements under section 16a-38k-6 of the Regulations of Conneticut State Agencies by receiving a Leadership in Energy and Environmental Design (LEED) Silver level certification from the United States Green Building Council, or by meeting the criteria set forth in the Northeast Collaborative for High Performance School Protocol, also known as NE-CHPS, providing that the project includes all mandatory requirements within sections 16a-38k-3, 16a-38k-5, and 16a-38k-8 of the Regulations of Connecticut State Agencies.

(NEW) Section 16a-38k-8. Reporting Requirements

(a) For projects as defined in sections 16a-38k-2(a) and 16a-38k-2(b) of the Regulations of Connecticut State Agencies:

(1) Upon successful awarding of the design contract, the design team shall provide a letter to both the commissioner and the secretary listing the project timeline and members of the design team and indicating understanding of the requirements of sections 16a-38k-1 through 16a-38k-9 of the Regulations of Connecticut State Agencies.

(2) Upon design development completion, a report shall be submitted to the Secretary and the Commissioner by the project manager facilitator on behalf of and signed off by the agency/municipality that will be responsible for the ongoing care, operation, and maintenance of the building. This submittal shall include details of how the agency is complying with the mandatory measures under section 16a-38k-3 of the Regulations of Connecticut State Agencies. Documentation shall also include which of the twenty-six measures of the sixty measure strategies are planned for implementation; or if the project is utilizing the alternative strategy outlined in section 16a-38k-7(a) of the Regulations of Connecticut State Agencies, the project manager-facilitator shall document how the design team intends to meet the alternative paths to compliance.

(3) At the end of the construction document phase, a report shall be prepared by the design team to include energy modeling for the current Connecticut State Building Code requirements versus the proposed building project and cost differentials and operational savings for the project. The report is to be provided to the project manager-facilitator for submittal to the secretary and the commissioner.

(4) If, at any time during the construction process, substitutions for the any of the twenty-six stated measure strategies are made, the commissioner and the secretary shall be notified by the project manager-facilitator in writing of the changes. These substitutions must be in conformance with the general requirements of the

project manual. Such changes shall be agreed to by the secretary and the commissioner. A pre-occupancy commissioning report shall be prepared by the commissioning agent that demonstrates that the project has met all of the requirements spelled out in sections 16a-38k-3 and 16a-38k-4 of the Regulations of Connecticut State Agencies; or alternatively, in sections 16a-38k-3 and 16a-38k-7 of the Regulations of Connecticut State Agencies. The report is to include all design elements of the project that
address each completed strategy in sections 16a-38k-3 and 16a-38k-4 of the Regulations of Connecticut State Agencies; or alternatively, in sections 16a-38k-3 and 16a-38k-7 of the Regulations of Connecticut State Agencies. The report shall be submitted to the commissioner and to the secretary with the seal of the professional engineer and signed off by the project manager-facilitator indicating that "this report certifies that the material contained herein is true and correct."

(5) A post-occupancy commissioning report shall be prepared by the commissioning agent and submitted by the agency that is responsible for the ongoing care, operation, and maintenance of the building to the secretary and the commissioner within one hundred eighty days after one year of occupancy. The report shall include results of any post-occupancy survey of building occupants, a description of any adjustments made to equipment or building operation and the reasons for which the changes were made, and one year of all energy usage by source and water usage.

(b) For projects as defined in sections 16a-38k-2(c) and 16a-38k-2(d) of the Regulations of Connecticut State Agencies:

(1) Upon successful awarding of the design contract, the design team shall provide a letter to the SDE commissioner listing the project timeline and members of the design team and indicating understanding of the requirements of sections 16a-38k-1 through 16a-38k-9 of the Regulations of Connecticut State Agencies.

(2) Upon design development completion, a report shall be submitted to the SDE commissioner by the project manager facilitator on behalf of and signed off by the agency/municipality that will be responsible for the ongoing care, operation, and maintenance of the building. This submittal shall include details of how the project is complying with the mandatory measures under sections 16a-38k-3 and 16a-38k-5 of the Regulations of Connecticut State Agencies. Documentation shall also include which of the twenty-eight measures of the fifty-nine measure strategies are planned for implementation; or if the project is utilizing the alternative strategy outlined in section 16a-38k-7(b) of the Regulations of Connecticut State Agencies, the project manager-facilitator shall document how the design team intends to meet the alternative paths to compliance.

(3) At the end of the construction document phase, a report shall be prepared by the design team to include energy modeling for the current Connecticut State Building Code requirements versus the proposed building project and cost differentials and operational savings for the project. The report is to be provided to the project manager-facilitator for submittal to the SDE commissioner.

(4) If, at any time during the construction process, substitutions for the any of the twenty-eight measure strategies are made, the SDE commissioner shall be notified by the project manager-facilitator in writing of the changes. These substitutions must be in conformance with the general requirements of the project manual. Such changes shall be agreed to by the SDE commissioner. A pre-occupancy commissioning report shall be prepared by the commissioning agent that demonstrates that the project has met all of the requirements spelled out in sections 16a-38k-3, 16a-38k-5, and 16a-38k-6 of the Regulations of Connecticut State Agencies; or alternatively, in sections 16a-38k-3, 16a-38k-5, and 16a-38k-7 of the Regulations of Connecticut State Agencies. The report is to include all design elements of the project that address each completed strategy in sections 16a-38k-3, 16a-38k-5, and 16a-38k-6 of the Regulations of Connecticut State Agencies; or alternatively, in sections 16a-38k-3, 16a-38k-5, and 16a-38k-7 of the Regulations of Connecticut State Agencies. The report shall be submitted to the SDE commissioner with the seal of the professional engineer and signed off by the project manager-facilitator indicating that "this report certifies that the material contained herein is true and correct."

(5) A post-occupancy commissioning report shall be prepared by the commissioning agent and submitted by the agency that is responsible for the ongoing care, operation, and maintenance of the building to the SDE commissioner within one hundred eighty days after one year of occupancy.. The report shall include results of any post-occupancy survey of building occupants, a description of any adjustments made to equipment or building operation and the reasons for which the changes were made, and one year of all energy usage by source and water usage.

(NEW) Section-16a-38k-9. Exemptions

Any exemption request shall be submitted to the secretary with the signature of the agency commissioner, deputy commissioner, president or vice president of the agency, or the chief operating officer of the municipality or school district that is responsible for the ongoing care, operation, and maintenance of the building. Within no more than forty-five days of submittal of an exemption request, the secretary, in consultation with the commissioner and the Institute of Sustainable Energy, may exempt a facility from complying with these regulations if the secretary finds, in a written analysis, that the cost of such compliance significantly outweighs its benefits. Requests for exemptions shall be

submitted to the secretary with cost/benefit calculations and life-cycle analysis and shall include:

(a) for projects as defined in sections 16a-38k-2(a) and 16a-38k-2(b) of the Regulations of Connecticut State Agencies:

(1) a description of the building project,
(2) documentation for such costs required to minimally meet the provisions of sections 16a-38k-3 and 16a-38k-4 of the Regulations of Connecticut State Agencies or, alternatively, sections 16a-38k-3 and 16a-38k-7 of the Regulations of Connecticut State Agencies,
(3) what efforts have been made to comply with the provisions of sections 16a-38k-3 and 16a-38k-4 of the Regulations of Connecticut State Agencies or, alternatively, sections 16a-38k-3 and 16a-38k-7 of the Regulations of Connecticut State Agencies,
(4) health and safety impacts of the building occupants and building management personnel, and
(5) the reason(s) for which such an exemption is necessary. In the case of an historic building, documentation of the building being on the State Register of Historic Places or the National Register of Historic Places shall be submitted.

(b) for projects as defined in sections 16a-38k-2(c) and 16a-38k-2(d) of the Regulations of Connecticut State Agencies:

(1) a description of the building project,
(2) documentation for such costs required to minimally meet the provisions of sections 16a-38k-3, 16a-38k-5 and 16a-38k-6 of the Regulations of Connecticut State Agencies or, alternatively, sections 16a-38k-3, 16a-38k-5 and 16a-38k-7of the Regulations of Connecticut State Agencies,
(3) what efforts have been made to comply with the provisions of sections 16a-38k-3, 16a-38k-5 and 16a-38k-6 of the Regulations of Connecticut State Agencies or, alternatively, sections 16a-38k-3, 16a-38k-5 and 16a-38k-7 of the Regulations of Connecticut State Agencies,
(4) health and safety impacts of the building occupants and building management personnel, and
(5) the reason(s) for which such an exemption is necessary. In the case of an historic building, documentation of the building being on the State Register of Historic Places or the National Register of Historic Places shall be submitted. If the secretary approves of any such exemption, the secretary shall notify the SDE commissioner in writing of such exemption.

STATEMENT OF PURPOSE

To adopt regulations establishing high performance construction standards for state owned buildings pursuant to Public Act 06-187, section 70 (a) and (b), and amended by Public Acts 07-213, 07-242 and 07-249. (1) State facility construction projects that are

projected to cost $5 million or more, and of which $2 million or more is state funding and is approved and funded on or after January 1, 2008; (2) renovation of state facilities that are projected to cost $2 million or more of which $2 million or more is state funding and is approved and funded on or after January 1, 2008; (3) new construction of school facilities projected to cost $5 million or more, and of which $2 million or more is state funding and is authorized by the General Assembly pursuant to chapter 173 on or after January 1, 2009; and (4) renovation of public school facilities costing $2 million or more of which $2 million or more is state funding and is authorized by the General Assembly pursuant to chapter 173 on or after January 1, 2009, are required to meet minimum standards for: energy efficiency & renewable energy; indoor environment; water efficiency; recycling, reuse & sustainability; site selection & development; and operations & procedures. Sections 16a-38k-1 through 16a-38k-9 establishes the criteria new building projects and renovations are expected to meet.

Building Commissioning

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(a)	Building commissioning shall be an integral part of the building project. Such commissioning shall be performed by an independent third-party, called a commissioning agent, who shall be certified as a commissioning agent by the Building Commissioning Association or the Association of Energy Engineers, and shall either be a Professional Engineer or have an S-1 license. This individual shall be included in the beginning stages of the building process through a post-occupancy evaluation. The commissioning agent shall not be an employee of the architectural, engineering, or construction firm that implements the project, and shall be hired directly by the state, municipality, or regional school district. For state facility projects, the commissioning agent may be an employee of the Department of Public Works provided such person shall act independently of the other staff assigned to oversee the design and construction of the project. The commissioning agent shall report all findings and recommendations to the owner of the state facility or the municipal or regional school district. Coordination and oversight of the training of facility management and maintenance personnel on proper equipment operation as well as verification of proper development of systems manuals shall be overseen by the commissioning agent in cooperation with the project manager-facilitator and with the building owner, designer, contractor, and subcontractors who installed the systems. The commissioning process, at minimum, shall include the following energy-related systems: (1) heating, ventilating, air conditioning, and refrigeration systems and associated controls, (2) lighting and day-lighting controls, (3) domestic hot water systems, (4) renewable energy systems. It is required that the commissioning process also include water using systems and the building envelope systems.

Purpose

Verify that fundamental building elements and systems are designed, installed, and calibrated to operate as intended and provide for the ongoing accountability and optimization of building energy performance over time.

Compliance Assistance for Mandatory Requirement

Definition of Commissioning

ASHRAE Guideline 0-1995: *The Commissioning Process*, defines commissioning as "a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria."

Commissioning uncovers deficiencies in design or installation using peer review and field verification. Proper commissioning reduces energy consumption and improves indoor air quality, environmental health, and occupant comfort and safety. Commissioning should provide preventive and predictive maintenance plans, tailored operating manuals, and operator training procedures. Properly completed, the commissioning process assures that project expectations are met, and that facility personnel are equipped to evaluate and maintain building systems.

Selecting a Commissioning Agent

Third party commissioning requires that the commissioning agent not be an employee of the architectural, engineering, or construction firm that implements the project. Many design teams now have a continuing relationship with a commissioning agent. Two sources to locate and hire an independent commissioning agent are the Building Commissioning Association and the Association of Energy Engineers. Both organizations maintain certification programs for commissioning agents.

Commissioning Goals

The goals of a commissioning plan for a newly constructed building should include:

- ❑ Defining commissioning requirements clearly at the outset of each phase and update through the process
- ❑ Verifying and documenting compliance at each completion level
- ❑ Establishing and documenting commissioning process tasks for subsequent phase delivery team members
- ❑ Delivering a project that meets the owner's needs at the time of completion
- ❑ Verifying that operation and maintenance personnel and occupants are properly trained
- ❑ Maintaining facility performance across its life cycle

The Commissioning Plan

A commissioning plan should do the following:

- ❑ Establish goals for quality, efficiency, and functionality
- ❑ Establish a commissioning approach and scope
- ❑ Establish commissioning budgets
- ❑ Establish commissioning plans
- ❑ Establish commissioning schedules
- ❑ Establish testing and inspection plans
- ❑ Develop commissioning specifications
- ❑ Determine special testing needs
- ❑ Establish re-commissioning plans

Commissioning Documentation

- ❑ Document all levels of project development and acceptance
- ❑ Document inspection, testing, and training activities on commissioned systems
- ❑ Create an operations manual for all commissioned equipment

Industry Guidelines

It is highly recommended that project teams who employ the Building Commissioning Process should follow the process outlined in *ASHRAE Guideline 0*. *Guideline 0* has been adopted by both ASHRAE and NIBS (see resource section below) and does not focus upon specific systems or assemblies, but presents a standard process that can be followed to commission any building system that may be critical to the function of a project. The NIBS Total Building Commissioning Program is currently working with industry organizations to develop commissioning guidelines for various systems and assemblies.

Enhanced Building Commissioning

This expands the role of the CA to include review of the design, construction documents, and submittals. In addition, the CA must develop and provide a system and energy management manual to help staff understand the equipment and operating procedures. The commissioning services must be performed by an independent entity – one that is separate from both the design firm and the contractors. For continuity in the commissioning process, it is recommended that the same agent be selected to perform all commissioning-related tasks.

The following are examples of tasks performed and documented in a commissioning report:

Conduct a focused review of the design prior to the construction documents phase. This review early in the design process should be focused on an assessment of how well the design meet's the owner's design intent. Assessment should be made as to how the design meets the functionality, utility performance, maintainability, sustainability, cost, and indoor environmental quality requirements outlined in the design intent.

Conduct a focused review of the construction documents. This review should be conducted prior to issuing the construction documents for bid. This review should answer these questions:

- ❑ Does the design meet the owner's design intent?
- ❑ Does the design allow for proper maintenance access?
- ❑ Do the construction documents clearly detail the construction requirements?
- ❑ Do the construction documents clearly define the commissioning requirements?

Conduct a selective review of contractor submittals of equipment to be commissioned. Contractor submittals for the systems and equipment included in the commissioning scope shall be reviewed by the CA in conjunction with the designer's review. The review shall focus on the ability of the submitted product to meet the owner's requirements and review comments shall be provided to the owner and the design team.

Develop a system and energy management manual. This manual is intended to improve and enhance the documentation of system intent and operation and to help the

building owner continue to operate the building systems as efficiently and effectively as possible throughout the life of the facility. The manual should cover the operations and maintenance of all HVAC and lighting systems, and the facility staff should be trained in the use of the manual. (Note that relative to schools, Section 10-220 of the Connecticut General Statutes **requires** that local or regional boards of education properly maintain school buildings and to "implement an indoor air quality program that provides for **ongoing maintenance** and facility reviews necessary for the maintenance and improvement of the indoor air quality of its facilities", and shall report on "the action taken to implement its long-term school building program and indoor air quality program".)

Conduct a near-warranty end, or post-occupancy, review. This review is intended to bring the design, construction, commissioning and O&M staff together to solicit the O&M staff comments, suggestions, and areas of concern regarding the systems in their first year of operation. Any warranty items should be identified and a plan for resolution developed.

Resources

- Building Commissioning (Whole Building Design Guide) http://www.wbdg.org/project/buildingcomm.php
- National Institute of Building Sciences (NIBS) http://www.nibs.org/
- Working Buildings, http://www.workingbuildings.com/home.jsp
- *CHPS Best Practices Manual*, vol. 2, Guideline GC5: Contractor's Commissioning Responsibilities, http://www.chps.net/
- ASHRAE Guideline 1-1996: *The HVAC Commissioning Process* and ASHRAE Guideline 4-1993: *Preparation of Operations & Maintenance Documentation for Building Systems*, http://www.ashrae.org.
- *LEED Reference Guide*, Energy and Atmosphere, U.S. Green Building Council, http://www.usgbc.org/

Relevant Codes and Standards

- *ASHRAE Guideline 0 - 2005: The Commissioning Process*—the industry-accepted Commissioning Guideline
- *The Building Commissioning Guide*, U.S. General Services Administration, 2005

Organizations and Associations

- ASHRAE—A leading organization in the development of standardized commissioning guidelines
- Building Commissioning Association—A leading professional association for membership and certification of building commissioning practitioners
- The Association of Energy Engineers (AEE) offers commissioning courses and maintains a certification program: http://www.aeecenter.org/certification/CBCPpage.htm
- U.S. Green Building Council

Publications

- *Building Commissioning: The Key to Quality Assurance* (PDF 1.0MB) U.S. Department of Energy Rebuild America Guide Series, 1998. Commissioning retrofits and existing buildings: overview, process, and case studies. 77 pp, PECI.
- *The Building Commissioning Handbook* 2nd Edition, by John A. Heinz, PE and Richard B. Casault, PE. Alexandria, VA: APPA: The Association of Higher Education Facilities Officers, Phone: (703) 684-1446, ISBN: 1-890956-28-7.
- Commissioning Four New Science Laboratory Buildings (U. of WA) by Bonneville Power Admin. / Phoebe Caner, Portland Energy Conservation Inc., 1997. Commissioning case studies with detailed "lessons learned" information. ~70 pp. Phone: (503) 230-7334.
- *The Cost-Effectiveness of Commercial-Buildings Commissioning: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States* by Evan Mills, Norman Bourassa and Mary Ann Piette of Lawrence Berkeley National Laboratory, Hannah Friedman and Tudi Haasl of Portland Energy Conservation Inc., Tehesia Powell and David Claridge of Energy Systems Laboratory, Texas A&M University. December 2004.
- *Guidelines for Incorporating Commissioning into Energy Savings Performance Contracts* PECI, October 2000.
- *A Practical Guide for Commissioning Existing Buildings* by Tudi Haasl of Portland Energy Conservation Inc. and Terry Sharp of Oak Ridge National Laboratory. April 1999.
- *What Commissioning Can Do For Your Building?* PECI, 1997. Derived from a database of 175 case studies of commissioning of new construction, equipment replacements, and upgrades in existing facilities. 12 pp. Phone: (503) 248-4636.

Tools

- GSA Project Planning Tools—A publicly available website that creates automated commissioning plans based on typical GSA delivery practices and processes

Integrated Design Process

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38 -3(b)	All building construction projects shall follow an integrated design process to set environmental and building performance goals. This process, at minimum, shall include at least one collaborative session of the design team consisting of the architect, mechanical engineer, electrical engineer, civil engineer, commissioning agent, a representative of the building owner, and representative(s) of the building tenant state agency prior to the preparation of contract documentation. The meeting shall include the owner's project requirements, the basis of design, commissioning plan, performance verification documentation, commissioning report, and post commissioning requirements. Prior to the start of the construction phase, at least one collaborative session among the designers, owner, and contractors, including the electrical, mechanical, and controls subcontractors shall be held to insure knowledge of design intent, required approval processes, and commissioning procedures. All records of decisions from the collaborative sessions shall be shared among the design team. The owner of the state facility or the municipal or regional school district shall have final decision making authority.

Purpose

Integrated design brings together the various disciplines involved in designing a building and reviews their recommendations as a whole. It also recognizes that each discipline's recommendation has an impact on other aspects of the building project. Design integration is the best way to avoid redundancy or conflicts with aspects of the building project planned by others. The design integration approach allows for optimization of both building performance and cost. It also allows professionals to take advantage of efficiencies that are not apparent when they are working in isolation.

Compliance Assistance for Mandatory Requirement

The earlier the integration is introduced in the design process, the greater the benefit. For a high performance building, project team collaboration and integration of design choices should begin during the early planning stages.

The integrated design process often includes integrating green design strategies into conventional design criteria for building form, function, performance, and cost. The goal is to achieve high performance and multiple benefits at a lower cost than the total for all the design components combined.

As an example, in an integrated design approach, the mechanical engineer will calculate energy use and cost very early in the design, informing designers of the energy-use

implications of building orientation, configuration, fenestration, mechanical systems, and lighting options.

The design and analysis process for developing integrated building designs includes:

- ❑ Establishing a base case—for example, a performance profile showing energy use and costs for a typical facility that complies with code (energy code compliance software COM*check* may be used to check compliance of the base case) and other measures for the project type, location, size, etc.
- ❑ Identifying a range of solutions—all those that appear to have potential for the specific project
- ❑ Evaluating the performance of individual strategies—one by one through sensitivity analysis or a process of elimination parametrics
- ❑ Grouping strategies that are high performers into different combinations to evaluate performance
- ❑ Selecting strategies, refining the design, and reiterating the analysis throughout the process

The integrated design process for high performance buildings should emphasize the following:

- ❑ Production of at least two, and preferably three, concept design alternatives using energy simulations, cost benefit calculations, and life-cycle analysis as a test of progress and then selecting the most promising of these for further development. The design alternatives should be modeled using a simulation tool that predicts the annual energy performance of the building on an hourly basis, as this will provide the basis for compliance with the energy efficiency requirements of this regulation. Acceptable energy modeling software programs include: DOE-2, VisualDOE, PowerDOE, EnergyPlus, and eQUEST. (see the Energy Performance section of this document for further information on building simulation modeling)
- ❑ Minimization of heating and cooling loads and the maximization of daylighting potential through building orientation and configuration and the design of an efficient building envelope with careful consideration given to the amount, type, and location of fenestration
- ❑ Fulfillment of heating and cooling loads through the maximum use of solar and other renewable technologies and the use of efficient HVAC systems
- ❑ Maintenance of performance targets for indoor air quality, thermal comfort, illumination levels and quality, and noise control. The design team should consider employing the services of a Certified Industrial Hygienist to ensure that indoor air quality goals are met.

Resources

- ❑ U.S. Environmental Protection Agency: http://www.epa.gov/iaq/schooldesign/predesign.html
- ❑ U.S. Department of Energy: Office of Energy Efficiency and Renewable Energy: http://www.eere.energy.gov/buildings/info/design/integratedbuilding/

- International Initiative for a Sustainable Built Environment: http://greenbuilding.ca/down/gbc2005/Other_presentations/IDP_overview.pdf
- COM*check* software for commercial code compliance http://www.energycodes.gov/comcheck/ez_download.stm
- The American Board of Industrial Hygiene www.abih.org/general/cihcaih.html

Energy Performance

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(c)	The base minimum energy performance for all building projects shall be 21 percent better than the most current Connecticut State Building Code or ASHRAE 90.1-2004, whichever is more stringent. Base minimum energy performance shall be determined using approved building modeling software that is identified in the following sections.

Purpose

To reduce total energy usage in the building, lowering operating costs, conserving valuable natural resources, and minimizing environmental impacts.

Compliance Assistance for Mandatory Requirement

The energy efficiency requirements (energy code) of the current Connecticut State Building Code are based on the 2003 International Energy Conservation Code, which references the requirements of ASHRAE Standard 90.1 2001 version with all approved and published amendments.

ASHRAE Standard 90.1 2004 version is substantially identical to the requirements in the current Connecticut State Building Code except that in ASHRAE 90.1-2004 there is only one heating zone instead of the three heating zones in the current code.

The code offers both prescriptive and building simulation methodologies for demonstrating compliance. In order to meet this requirement of the High Performance Building Construction Standards for State-Funded Buildings, the building simulation methodology must be used to demonstrate that the building will perform better than the same building built to energy code standards. This compliance methodology is typically referred to as a “systems analysis” approach, and is termed in the energy code as the “energy cost budget method,” and “total building performance.”

In order to utilize this approach, the building must be modeled using a simulation tool that predicts the annual energy performance of the building on an hourly basis. Acceptable energy modeling software programs include: DOE-2, VisualDOE, PowerDOE, EnergyPlus, Trace™ 700, and eQUEST.

Although the energy code allows optional prescriptive compliance paths, it is recommended that the “energy cost budget method” be used for both compliance with the code and this regulation, easing burdens on the design team. Upon completion of the building simulation modeling, the documentation requirements as stipulated in the energy code may be submitted to document compliance with this regulation.

Resources

- ❑ Electronic version of the Connecticut State Building Code – Connecticut Supplement is available from the Office of State Building Inspector Web page that can be accessed through the State of Connecticut, Department of Public Safety website: http://www.ct.gov/dps/
- ❑ Paper and electronic versions of the Connecticut Building Code (International Building Code Portion of the State Building Code, State of Connecticut) and the International Energy Conservation Code are available from the International Code Council on their website http://www.iccsafe.org under ICC Store and State/Local Codes.
- ❑ Main page: http://www.iccsafe.org/

ENERGY STAR Specification

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(d)	Energy consuming products installed in the building shall be ENERGY STAR compliant if the product category has an ENERGY STAR specification.

Purpose

To reduce the energy use of equipment installed in the building. Building energy use is not only associated with heating, cooling, and lighting, but also with the supplementary equipment utilized in normal operations. Plug-loads have become a rapidly growing portion of operating budgets because of the reliance on computer systems and other equipment.

Background Information

The ENERGY STAR program was established jointly by the U.S. Department of Energy and the U.S. Environmental Protection Agency to provide accuracy and consistency in energy usage ratings and to encourage the purchase of efficient equipment. The program includes ratings for many types of equipment commonly used in commercial and government buildings, including:

- ❑ Computers
- ❑ Monitors
- ❑ Printers
- ❑ Scanners
- ❑ Copy machines
- ❑ Water coolers
- ❑ Refrigerators
- ❑ Ceiling fans
- ❑ Washing machines
- ❑ Vending machines
- ❑ Compact fluorescent lamps
- ❑ Exit signs
- ❑ Residential/small commercial HVAC equipment

Compliance Assistance for Mandatory Requirement

ENERGY STAR compliant equipment is readily available and can be identified by an ENERGY STAR "mark" on the appliance, its packaging, or on the "EnergyGuide" label. In addition, the ENERGY STAR program maintains a database of eligible equipment (see the resources section below).

All product categories having an ENERGY STAR specification that are installed in the building must be ENERGY STAR compliant. This includes plug-in devices as well as permanently installed "hard-wired" equipment.

Compliance Considerations for Lighting and HVAC Systems

While permanently installed products or systems must be ENERGY STAR compliant if the product/system has an ENERGY STAR specification, complying with Section 16a-38k-3 subsection (c) and/or with Section 16a-38k-4 subsections (a) 1 through 6 may require higher efficiencies than the ENERGY STAR minimums. Complying with this section does not relieve you from complying with Section 16a-38k-3 subsection (c).

Resources

The ENERGY STAR program offers many resources to assist in choosing and purchasing energy efficient equipment:

- ❑ General information and links to all ENERGY STAR resources: http://www.energystar.gov/
- ❑ Bulk purchasing: http://www.energystar.gov/index.cfm?c=bulk_purchasing.bus_purchasing
- ❑ Government purchasing: http://www.energystar.gov/ia/business/bulk_purchasing/Govt_FactSheet.pdf.
- ❑ ENERGY STAR stores: http://www.energystar.gov/index.cfm?fuseaction=store.store_locator

Indoor Air Quality Management Plan

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(e)	The project manager-facilitator shall develop an indoor air quality management plan for the construction phase of the project. As part of the plan, the following shall be addressed: (1) Periodic inspections of materials stored on-site to ensure that all installed or stored absorptive materials are protected from moisture and mold damage. If resting on the ground, spacers shall be provided to allow air to circulate between the ground and the materials. All water-damaged materials shall be removed from the site and disposed of properly. (2) Surface grades, drainage systems, and heating, ventilating and air conditioning condensate drainage systems shall be designed so as to prevent accumulation of water under, in, or near the building. Irrigation systems shall be designed so as to prevent spraying of the building. (3) Ductwork shall be sealed from outside elements during transport and storage, and interior surfaces shall be wiped down immediately prior to installation. During installation, open ends of ductwork shall be temporarily sealed and ductwork shall be protected with surface wrapping. No installed ductwork shall contain internal porous insulation materials or lining. (4) Heating, ventilation, and air conditioning (HVAC) equipment shall be covered and protected from moisture during transportation and on-site storage. For permanently installed air handlers used during construction, use filtration media in air handlers with a Minimum Efficiency Reporting Value (MERV) of ten, except for unit ventilator systems which shall have a minimum MERV of seven. All filtration media shall be replaced immediately prior to building occupancy with media having a MERV rating of equal or greater value to existing media. (5) Materials that off-gas toxic or potentially toxic fumes shall be pre-conditioned for at least seventy-two hours prior to installation within the building. Such materials shall also be installed prior to the installation of porous building materials to reduce absorption and adsorption of those toxins by the porous materials. Prior to installation of porous materials and materials vulnerable to mold, the building enclosure shall be watertight. (6) In the event that any portion of the building is occupied during construction or renovation activities, the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) *Indoor Air Quality Guidelines for Occupied Buildings Under Construction* shall be followed.

Purpose

Establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, which will contribute to the comfort and well-being of the occupants.

Compliance Assistance for Mandatory Requirement

In order to assure compliance with the IAQ requirements, project owners should be sure that construction documents specify that the mandatory requirements are met. The project manager-facilitator shall be designated to supervise and oversee the construction site for compliance with these requirements during all phases of construction. Consulting with a Certified Industrial Hygienist should be considered. Photo documentation is necessary.

ASHRAE Standard 62.1-2004 and the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) *IAQ Guideline for Occupied Buildings Under Construction* both contain detailed guidance for complying with these IAQ requirements.

Resources

- ASHRAE Standard 62.1-2004: http://sspc621.ashraepcs.org/
- Sheet Metal and Air Conditioning National Contractors Association (SMACNA) *IAQ Guideline for Occupied Buildings Under Construction*, 1995: http://www.smacna.org/newsletters/index.cfm?fuseaction=view_article&id=3197
- LEED-NC, Green Building Rating System For New Construction & Major Renovations, Version 2.2, October 2005: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220
- LEED for Schools-for New Construction and Major Renovation, First Edition, November 2007 http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1586
- The American Board of Industrial Hygiene www.abih.org/general/cihcaih.html
- Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA): http://www.smacna.org/

Water Usage

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(f)	Use low-flow fixtures to consume twenty percent less water in aggregate as compared to base levels calculated by meeting the Federal Energy Policy Act of 1992 fixture performance requirements. Calculations shall be based on estimates of occupant usage and shall include the following building fixtures only: showers, urinals, toilets, bathroom sink faucets, and kitchen sink faucets.

Purpose

Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Compliance Assistance for Mandatory Requirement

Develop a water-use baseline including all water-consuming fixtures, equipment, and seasonal conditions according to methodology outlined below. Specify water-conserving plumbing fixtures that exceed the Energy Policy Act (EPAct) of 1992's fixture requirements in combination with ultra high efficiency or dry fixture and control technologies. Specify high water efficiency equipment (e.g., dishwashers, faucets, cooling towers, composting toilet systems and non-water using urinals, and occupant sensors to reduce the potable water demand). Consider reuse of stormwater and greywater for non-potable applications such as toilet and urinal flushing and custodial uses. Check all local and state codes before proceeding with a greywater or stormwater reuse system

To calculate water use reductions, use spreadsheets similar to those displayed in the following tables, detailing baseline and design water uses. List each water-using appliance or fixture, the amount of daily uses, number of occupants, and total water use. A base design and a water-efficient design for a building with 500 occupants are illustrated below.

Table 1: Proposed Design Indoor Water Consumption Calculation

Fixture Type	Flow-rate	Duration	Occupants	Daily uses	Water use
Low-flow toilet (male)	1.6 gal/flush	1 flush	500	1	800
Waterless urinal	0.0 gal/flush	1 flush	500	2	0
Low-flow toilet (female)	1.6 gal/flush	1 flush	500	3	2400
Bathroom sink	0.5 gal/min	0.17 min	1000	3	255
Low-flow shower	1.8 gal/min	5 min	100	1	900
Low-flow kitchen sink	1.8 gal/min	45 min	2	2	324
Efficient clothes washer	20 gal/load	1 load	-	10	200
Total daily volume					4879
Building operating days					180
Subtotal					878,220
Minus collected rainwater					(396,000)
Design total annual volume					482,220

For the baseline calculation, create a similar spreadsheet but change the type of fixture and its associated design details. The baseline calculation for this example would therefore be:

Table 2 – Baseline Indoor Water Consumption Calculation

Fixture Type	Flow-rate	Duration	Occupants	Daily uses	Water use
Conventional toilet (male)	1.6 gal/flush	1 flush	500	1	800
Conventional urinal (male)	1.0 gal/flush	1 flush	500	2	1000
Conventional toilet (female)	1.6 gal/flush	1 flush	500	3	2400
Bathroom sink	0.5 gal/min.	0.5 min	1000	3	750
Conventional shower	2.5 gal/min	5 min	100	1	1250
Kitchen sink	2.5 gal/min	45 min	2	2	450
Clothes washer	40 gal/load	1 load	-	10	400
Total daily volume					7,050
Building operating days					180
Baseline total annual volume					1,269,000

Comparing the two spreadsheets, the water-efficient fixtures reduced potable water use by:

% Savings = 1 – (Design Total Annual Volume / Baseline Total Annual Volume)

= 1 – (482,220/1,269,000) = 0.62 = 62%

Therefore, this design would qualify because overall potable water use has been reduced by over 20%.

Recyclable Materials

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(g)	The building or building site shall contain convenient areas to serve as collection points for recyclable materials and shall include an area for the sorting and storage of such materials for pick-up by recyclers.

Purpose

To facilitate the reduction of waste generated by building occupants that is hauled to and disposed of at a resource recovery facility or in a landfill and to reduce the consumption of new raw materials, thereby reducing energy required for the virgin production.

Compliance Assistance for Mandatory Requirement

The recycling program is part of the state's Solid Waste Management Plan, which examines the state of solid waste management in Connecticut, establishes goals and objectives, identifies problems and barriers, and outlines strategies for achieving the goals.

Information on materials recycling and recommended procedures is provided in the Recycling Law and Regulation, under the municipal solid waste recycling program (§§22a-241 through 22a-256 of the Connecticut General Statutes). Compliance with these requirements is mandatory.

Resources

- ❑ Contact the Connecticut DEP for materials and resources on reduce/reuse/recycle issues, http://www.ct.gov/dep/cwp/view.asp?a=2714&q=324882&depNav_GID=1645&depNav=|
- ❑ DEP main site: http://www.ct.gov/dep
- ❑ Regulation relating to recycling in State of Connecticut http://www.cga.ct.gov/2005/pub/Chap446d.htm

Erosion and Sedimentation Control

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(h)	All construction shall include a plan for erosion and sediment control, as required by sections 22a-325 through 22a-329 of the Connecticut General Statutes.

Purpose

To reduce the loss of soil from the site and to prevent pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust generation.

Compliance Assistance for Mandatory Requirement

Soil erosion and sedimentation pollute water and air by clogging the storm drains and streams, depositing pesticides and nutrients into the water, and causing particles of matter to loosen and enter the air. An erosion and sedimentation control (E&SC) plan describes the measures associated with controlling soil erosion and sedimentation during construction. The following are basic principles for effective soil erosion and sedimentation control:

- ❑ Use effective site planning to avoid sensitive areas such as wetlands and watercourses.
- ❑ Keep land disturbance to a minimum.
- ❑ Stabilize disturbed areas.
- ❑ Phase land disturbance on larger projects, starting subsequent phases after disturbed areas are stabilized.
- ❑ Keep runoff velocities low.
- ❑ Protect disturbed areas from stormwater runoff.
- ❑ Incorporate proper perimeter control practices.
- ❑ Limit construction during months when runoff rates are higher due to decreased infiltration or extreme rainfall events.
- ❑ Assign responsibility for and implement a thorough maintenance and follow-up program.

Information on soil erosion and sedimentation control practices and recommended procedures for developing an effective E&SC Plan are provided in the 2002 Guidelines for Soil Erosion and Sediment Control (Connecticut DEP Bulletin 34). The guidelines fulfill the requirements of Connecticut's Soil Erosion and Sedimentation Control Act (§§ 22a-325 through 22a-329 of the Connecticut General Statutes). Compliance with these requirements is mandatory for many municipal planning regulations and land development permits in Connecticut.

Copies of the 2002 Guidelines for Soil Erosion and Sediment Control can be purchased from the Connecticut DEP Inland Water Resources Div. For current availability of printed or electronic copies please call (860) 424-3706.

Resources

- Connecticut Department of Environmental Protection, Stormwater Program: http://www.ct.gov/dep/cwp/view.asp?a=2721&q=325702&depNav_GID=1654
- CHPS Best Practices Manual, vol. 2, Guideline GC4: Site Protection During Construction: http://www.chps.net/
- LEED Reference Guide, Site Prerequisite 1: Erosion and Sedimentation Control: http://www.usgbc.org/
- U.S. Environmental Protection Agency Stormwater Management for Construction Activities: http://cfpub.epa.gov/npdes/stormwater/swppp.cfm
- U.S. Environmental Protection Agency Construction General Permits: http://cfpub1.epa.gov/npdes/stormwater/cgp.cfm
- U.S. Environmental Protection Agency Construction General Permit Information: http://www.epa.gov/NE/npdes/stormwater/construction_act_ma.html

No Smoking

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(i)	No smoking shall be permitted in any building or portion of a building owned and operated or leased and operated by the state or any political subdivision thereof as mandated by section 19a-342 of the Connecticut General Statutes. All exterior designated smoking areas shall be located at least twenty-five feet away from outdoor air intakes, operable windows, and building entrances.

Resources

Connecticut General Assembly – Statutes:
http://search.cga.state.ct.us/dtsearch_pub_statutes.html

Integrated Pest Management Plan (IPM)

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(j)	A plan for integrated pest management as defined in section 22a-47 of the Connecticut General Statutes, shall be established as required under section 22a-66*l* for general pest control in state buildings. Schools shall comply with sections 10-231 and 22a-66*l* of the Connecticut General Statutes.

Purpose

To protect the health of building occupants and prevent structural damage by excluding pests from buildings with limited use of harmful chemicals. Insect and rodent allergens are known triggers for asthma, and pest infestation affects a range of other human health issues. In addition pest infestation can be damaging to building structure and systems.

Compliance Assistance for Mandatory Requirement

Integrated pest management (IPM) is defined in Section 22a-47 of the Connecticut General Statutes as "the use of all available pest control techniques including judicious use of pesticides, when warranted, to maintain a pest population at or below an acceptable level, while decreasing the unnecessary use of pesticides".

Section 22a-66*l* of the Connecticut General Statutes directs that "each state department, agency, or institution shall use integrated pest management at facilities under its control if the Commissioner of Environmental Protection has provided model pest control management plans pertinent to such facilities". The Department of Environmental Protection has established model integrated pest plans to assist with the development of comprehensive integrated pest management programs at state departments, agencies, and institutions.

The primary goal of IPM is to reduce the amounts of pesticides applied by using alternative methods of pest control which may include structural maintenance, sanitation, and mechanical or biological control. These methods will help to eliminate conditions that are favorable to pest infestation, making their survival more difficult.

IPM seeks to exclude pests from buildings and to destroy the habitat of pests by limiting their access to food, water, and free movement without dependence upon chemicals that are harmful to human health. Regular monitoring and record keeping is used to determine when treatments are needed to keep pest numbers low enough to prevent damage. Chemical controls should be used only when necessary and in the least toxic and volatile formulations that are effective.

Research demonstrates that the use of insecticides and rodenticides helps to limit infestations, but does not eliminate them. Over time, repeated application of pesticides may lead to resistance among targeted species, requiring greater amounts, or the use of more toxic materials to achieve the same effect.

The general pest control referenced in this regulation is intended for the control of cockroaches, ants (other than carpenter ants), winged termite swarmers emerging indoors,

incidental/occasional invaders including bees and wasps entering from out of doors, and flies and other arthropod pests. Populations of these pests that are located immediately outside of a specified building and pose a possible infestation problem to that building are included.

For control of other pests, the state also provides model plans for rodent control and for turf management.

Additional IPM Measures

In addition to the mandated IPM measures, the following pest management measures will help to reduce the reliance on pesticides:

- ❑ For all exterior walls, foundations, attics, roofs, utility chases, interior partitions and ceilings in food storage, preparation, and disposal areas, and penetrations:

Block all openings in the enclosure larger than 1/4 inch by 1/4 inch with concrete or mesh reinforced caulk or copper or stainless mesh, or screen over openings that must allow air flow.

Caulk all cracks larger than 1/16th inch, including all plumbing and electrical penetrations.

- ❑ Keep all shrubbery a minimum of 3 feet from the building structure.
- ❑ Utilize dumpsters and other rubbish containers that seal tightly and locate them as far away from the building as practicably possible.
- ❑ Do not allow debris to collect near doors and other building openings.
- ❑ Design building facades so that pigeons cannot roost.
- ❑ Maintain a schedule for the cleaning and degreasing of stoves, refrigerators, cabinets, floors, and walls in kitchens, bathrooms, teacher lounges, etc.

Resources

- ❑ Connecticut Department of Environmental Protection Model IPM Plans: http://www.ct.gov/dep/cwp/view.asp?a=2710&q=324300
- ❑ Connecticut Department of Environmental Protection Pest Management Information: http://www.ct.gov/dep/cwp/view.asp?a=2710&q=324266&depNav_GID=1712
- ❑ University of Connecticut Extension Service Integrated Pest Management Program: http://www.hort.uconn.edu/IPM/
- ❑ EPA: *IPM for Schools: A How-to Manual:* http://www.epa.gov/pesticides/ipm/schoolipm/index.html
- ❑ EPA Pesticides Program Information: http://www.epa.gov/pesticides/

Chlorofluorocarbon (CFC)-Based Refrigerants

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(k)	Chlorofluorocarbon (CFC)-based refrigerants shall not be utilized for energy systems in new construction. For renovation projects where existing HVAC-R equipment is reused, a CFC phase-out conversion shall be undertaken.

Purpose

The purpose of this measure is to reduce the harmful effects of CFCs on the environment and public health. The phase-out of CFCs will enable Earth's stratospheric ozone layer to recover, thereby reducing the harmful effects of excessive UV exposure to plants and animals. The phase-out is also expected to reduce the numbers of incidence of skin cancer, cataracts, and non-melanoma skin cancer.

Background Information

CFCs: CFCs are any of various halocarbon compounds consisting of carbon, hydrogen, chlorine, and fluorine, used widely as aerosol propellants and refrigerants.

Some Alternatives to CFCs	Uses
HCFC 22	Refrigeration
HCFC 123	Refrigeration
HFC 23	Fire Extinguishers
HFC 32	Refrigeration
HFC 125	Refrigeration
HFC 134a	Refrigeration, foams, air conditioning, medical aerosols

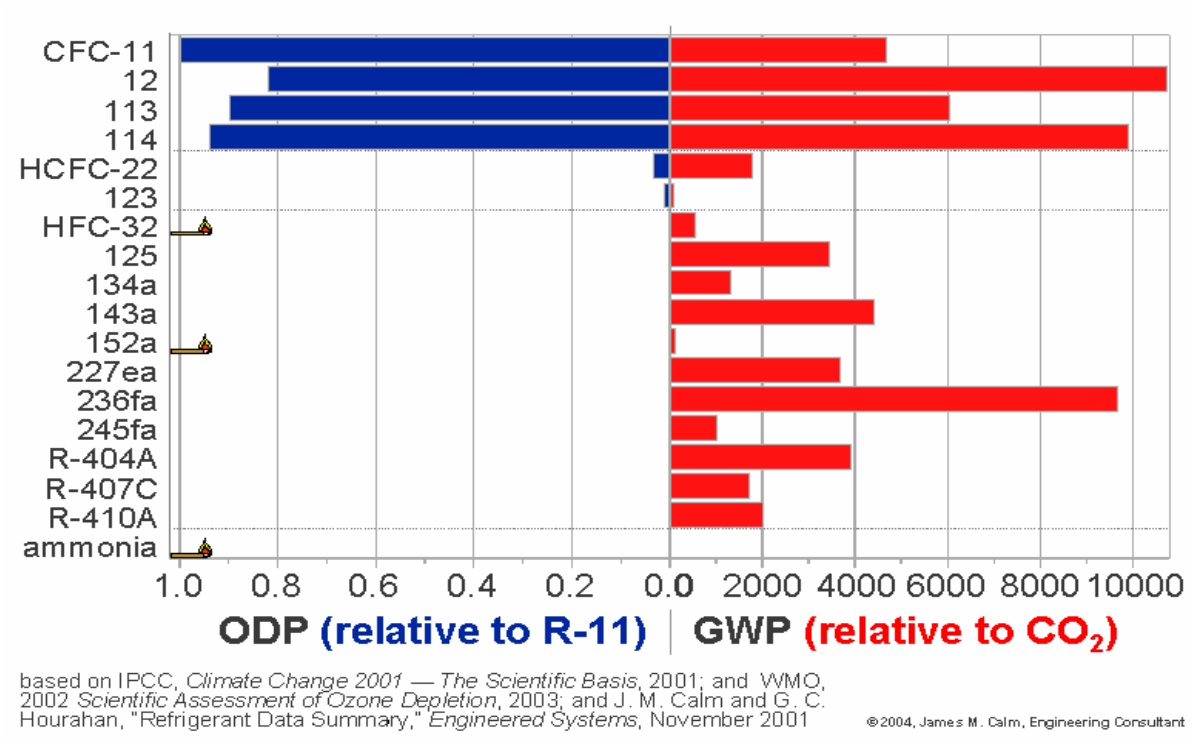
HCFCs: Hydrochlorofluorocarbons (HCFCs) are one class of chemicals being used to replace CFCs. They contain chlorine and thus deplete stratospheric ozone, but to a much lesser extent than CFCs. Different HCFCs have different effects on ozone depletion and global warming potential (see table, next page). HCFC-22 is scheduled to be phased out in 2010 for new equipment and 2020 for service applications. HCFC-123 can be manufactured until 2030, while recycled/recovered or stockpiled product can be used after that date. Project owners should consider the phase-out dates and the effects on the ozone layer and global warming when selecting equipment.

The National Oceanic and Atmospheric Administration provides more detailed information about HCFCs on their website (see the resources section).

HFCs: Hydrofluorocarbons (HFCs) are a class of chemicals that were developed to replace the CFC's. The HFCs contain no chlorine, and have almost no impact on the stratospheric ozone layer, and are therefore not controlled under the Montreal Protocol. HFCs do have an impact on global warming, and HFC's are one of the classification of chemicals that that have been called out for reduction in the Kyoto Protocol due to

their contribution to global warming. There is currently no phase out date for HFC's in the United States

OZONE DEPLETION POTENTIAL VS. GLOBAL WARMING POTENTIAL



Compliance Assistance for Mandatory Requirement

New construction shall include HVAC and refrigeration units that are CFC free. Project owners should direct the design team and/or the mechanical engineering design firm to specify all HVAC and refrigeration equipment to be CFC free. Alternative refrigerants may be any of the non-CFC alternatives.

Renovation projects must include a replacement schedule for CFC refrigerants. It is recommended that at a minimum, the replacement schedule mandates that when a CFC unit fails, it be replaced by a CFC free unit. Because modern HVAC and refrigeration units are significantly more efficient than older equipment, a more aggressive replacement schedule may prove to be desirable.

Minimum Ventilation Requirement

Mandatory Requirement—All Buildings

Mandatory Requirement Section 16a-38k-3(*l*)	Buildings shall be designed to meet the minimum ventilation requirements of the current ASHRAE Standard 62.1 using the Ventilation Rate Procedure for mechanical systems. If the current Connecticut State Building Code contains more stringent requirements, it shall be used to meet minimum ventilation requirements.

Purpose

To establish a baseline for minimum indoor air quality performance contributing to the health and comfort of the building occupants.

Building Standard Optional Strategies- State Facilities

Energy Efficiency and Renewable Energy

The following eleven strategies are available for demonstrating within the energy efficiency and renewable energy category. At least one option in this category must be selected:

Section 16a-38k-4(a)(1): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 3 1/2 percent.

Section 16a-38k-4(a)(2): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 7 percent.

Section 16a-38k-4(a)(3): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 10 1/2 percent.

Section 16a-38k-4(a)(4): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 14 percent.

Section 16a-38k-4(a)(5): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 17 1/2 percent

Section 16a-38k-4(a)(6): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 21 percent.

Compliance Assistance for Optional Strategies (a)(1) through (a)(6)

The above options use the same compliance methodologies and tools as the requirements outlined in Section 16a-38k-3 (see pages 9 of this document), and they may be used cumulatively. For example, complying with option 3 also puts you in compliance with options 1 and 2 and thus provides 3 (as opposed to just 1) of the 25 total strategies needed for project compliance.

Section 16a-38k-4 (a)(7): The installation of on-site renewable energy shall provide at least 3 percent of the building energy needs based upon the most recent version of the U. S. Department of Energy Commercial Buildings Energy Consumption Survey for estimated electricity usage or by using the same modeling software used to demonstrate compliance with the energy efficiency section of this document. Any facility that installs renewable energy systems must retain associated RECs for a period of two years.

Section 16a-38k-4(a)(8): Same as in subsection (a)(7) except at least 7 percent of the building energy needs are met through on-site renewable energy.

Section 16a-38k-4(a)(9): Same as in subsection (a)(7) except at least 10 percent of building energy needs are met through on-site renewable energy.

Compliance Assistance for Optional Strategies (a)(7) through (a)(9)

Renewable energy is classified as:

- ❑ Solar thermal systems
- ❑ Solar electric (photovoltaic systems)
- ❑ Wind power
- ❑ Methane landfill gas

- ❑ Low-impact hydropower (free-flow/no-head, or low-head systems)
- ❑ Biomass from locally available sources
- ❑ Biodiesel
- ❑ Fuel Cells

Geothermal heat pumps are not considered renewable energy systems for the purposes of this option. See "Building Innovations"

Solar thermal systems often offer the best investment in solar energy. Meeting a portion of the building's space heating, domestic water heating, or both loads combined is possible with a variety of system types and configurations. Systems dedicated to domestic water heating needs are often a good choice, as there is a demand for hot water year round.

Photovoltaic systems collect solar energy and directly convert it to electricity. The electricity generated is direct current (DC) and is either used to power DC devices or, more commonly, is converted (inverted) to alternating current (AC) to be used on-site for AC devices and/or supplied to the local electrical grid. Building and ground mounted systems are available.

Wind energy has been rapidly gaining in popularity, and many countries now meet significant portions of their electrical needs with wind generators. Today's slow rpm generators have solved many of the maintenance concerns and have greatly reduced the negative effects on bird life. The siting of wind generators is a long-term process, so planning must begin early. It is not unusual for the available wind to be monitored for at least a one-year period before selecting a site.

Methane landfill gas can be used to directly power boilers or may be used as a fuel source for fuel cells. The gas is corrosive so precautions must be taken to protect system components.

Low-impact hydroelectric power systems take advantage of the natural flow of rivers and streams, rather than utilizing dams to control the flow of water.

Qualifying biomass energy systems use locally grown biomass that is cultivated and harvested in a sustainable manner. Waste wood products and/or wood products from sustainable practices are eligible fuel sources.

Biodiesel is a fuel made from plant materials and/or waste cooking oils. Most commercially available biodiesel is produced from soybeans. Various biodiesel products are available including 100% biodiesel (commonly referred to as B100). Fuel mixes of biodiesel and conventional diesel are also commercially available including B20, B50, and B80 with 20%, 50%, and 80% biodiesel content respectively. In calculating the percentage of renewable energy utilized at the facility, only the actual biodiesel content is to be included. For example, if 10% of the energy is supplied by B50 biodiesel, the renewable contribution to the total energy consumption is 5%.

Resources

- General information and links to Connecticut Clean Energy Fund: www.ctcleanenergy.com
- Resources for building modeling software: http://www.eere.energy.gov/buildings/highperformance/simulation_software.html
- Database of state incentives for renewable energy and efficiency: http://www.dsireusa.org/
- U. S. Department of Energy Commercial Buildings Energy Consumption Surveys: http://www.eia.doe.gov/emeu/consumption/index.html
- CHPS Best Practices Manual, vol. 2: Guideline OS1: http://www.chps.net/
- LEED Reference Guide, Energy and Atmosphere Credit 2: Renewable Energy: http://www.usgbc.org/
- Advanced Buildings Reference Guide: Renewable Energy: http://www.poweryourdesign.com/refguide.htm

Renewable Energy Credit (REC) Options

Section 16a-38k-4(a)(10): The facility shall have a two-year contract to purchase at least 35 percent of the building's annual electricity consumption from a Class I renewable energy source. Alternately, the purchase may be in the form of New England Power Pool Generation Information System (NEPOOL-GIS) renewable energy credits (RECs); if procuring RECs outside of the NEPOOL-GIS, the RECs shall be equivalent to Class I renewable energy source and certified by a nationally recognized certification organization as identified in the *Connecticut State Facilities Building Standard Guidelines Compliance Manual for High Performance Buildings*; or the purchase may be through the CTCleanEnergyOptions™ program . Baseline electric usage can be determined using either the most recent version of the U. S. Department of Energy Commercial Buildings Energy Consumption survey for estimated electricity usage or by using building modeling software that is identified in the *Connecticut State Facilities Building Standard Guidelines Compliance Manual for High Performance Buildings.* RECs purchased to comply with this section cannot be purchased from a facility that has installed renewable energy systems for credit under 16a-38k-3(a)(7 through 9).

Compliance Assistance for Optional Strategy (a)(10)

Determine the energy needs of the building and comply with one of the following three methodologies:

1. Sign a two-year contract with a clean energy provider to purchase renewable energy credits representing at least 35% of the building's annual electricity consumption from a Class 1 renewable energy source. Connecticut Light and Power (CL&P) and United Illuminating (UI) both offerclean energy contracts. See the resources section for more information.

Class I renewable energy source is defined as energy derived from:

- Solar power
- Wind power

- Fuel cells
- Methane gas from landfills
- Ocean thermal power
- Wave or tidal power
- Low emission advanced renewable energy conversion technologies
- Waste heat recovery systems installed on or after July 1, 2006, that produce electrical or thermal energy by capturing preexisting waste heat or pressure from industrial or commercial processes
- Run-of-the-river hydropower facilities with generating capacities of not more than five megawatts, do not cause an appreciable change in the river flow, and began operation after July 1, 2003
- Biomass facilities, including, but not limited to, biomass gasification plants that utilize land clearing debris, tree stumps, or other biomass that regenerates and/or will not result in a depletion of resources, provided such biomass is cultivated and harvested in a sustainable manner and the average emission rate for such facility is equal to or less than .075 pounds of nitrogen oxide per million Btu of heat input for the previous calendar quarter, except that energy derived from a biomass facility with a capacity of less than five hundred kilowatts that began construction before July 1, 2003, may be considered a Class I renewable energy source, provided such biomass is cultivated and harvested in a sustainable manner. (NOTE: Sustainable biomass does not mean construction and demolition waste, finished biomass products from sawmills, paper mills or stud mills, organic refuse derived separately from municipal solid waste, or biomass from old growth timer stands.)

2. Purchase Class 1 renewable energy credits through the New England Power Pool Generation Information System (NEPOOL-GIS) equal to at least 35% of the building's annual electricity consumption. The credits are offered through brokers. See the resources section for a link to NEPOOL certificate brokers.

3. Purchase renewable energy credits through an independent source. The credits must be equivalent to Class I renewable resources and certified by a nationally recognized certification organization such as the Green-e Program offered by the Center for Resource Solutions. See the resources section for a link to the Green-e certificate program.

Renewable Energy Credits

Renewable Energy Credits (RECs) also known as Tradable Renewable Certificates (TRCs) allow a user of electricity to purchase credits for the production of renewable energy that offsets the generation of electricity by conventional means. This allows purchasers to participate in the renewable energy marketplace when locally produced renewable energy is not available. The purchase of RECs allows renewable energy generating facilities to be built where they are most cost-effective, while allowing customers anywhere to participate.

RECs may have monetary value and can be traded on the open market. Participants purchasing RECs to meet the requirements of this regulation may not

sell the RECs unless meeting the renewable energy requirement through an alternative method.

Resources

- ❑ Renewable energy credit (REC) New England Power Pool (NEPOOL) program: http://www.nepoolgis.com/
- ❑ Renewable energy credit (REC) Certificate Brokers NEPOOL program: http://www.nepoolgis.com/newsRoom/update02.asp
- ❑ Green-e renewable energy credit (REC) purchasing and certification program: http://www.green-e.org/base/re_products?cust=b
- ❑ The following article describes the NEPOOL REC system as it applies to the State of Connecticut: http://www.evomarkets.com/assets/evobriefs/nw_1062599800.pdf
- ❑ Details of the CT Clean Choice™ clean energy program offered by the DPUC for customers of CL&P and UI can be found at: http://www.sterlingplanet.com/bizBuyCT.php
- ❑ Details of the Community Energy clean energy program offered by the DPUC for customers of CL&P and UI can be found at: http://www.newwindenergy.com/
- ❑ CL&P's clean energy program information is available at: http://www.cl-p.com/community/environment/clean.asp
- ❑ Information on UI's clean energy program can be found at: http://www.uinet.com/index.asp

Energy Resource Management: The following strategy is available for renewable and non-renewable energy consumption.

Section 16a-38k-4(a)(11): Develop a measurement and verification plan for energy usage, to cover a period of at least one year after occupancy.

Compliance Assistance for Optional Strategy (a)(11)

This point can be obtained by instituting a plan to monitor and record energy usage for at least one year. A variety of data logging equipment and services are available for the measurement and verification (M&V) of the energy consumption of various systems throughout the building. Contact your electric and gas suppliers for assistance with establishing an M&V process for your facility.

Building Standard Optional Strategies- State Facilities

Indoor Environment

The following fourteen strategies are available for improving indoor environment. At least two strategies in this category must be selected:

Section 16a-38k-4(b)(1): Install permanent indoor air monitoring systems to provide performance feedback on ventilation systems. Such monitoring systems, at minimum, shall include devices to measure temperature, relative humidity, carbon dioxide, and dew point. Carbon dioxide measurement sensors shall measure both interior and exterior levels of CO2.

Compliance Assistance for Optional Strategy (b)(1)

Air monitoring is an indicator of potential problems within a building. Continuous air sampling allows the building operator to identify potentially unhealthy conditions so that adjustments can be made to resolve the conditions.

According to the LEED New Construction Rating System, carbon dioxide should be monitored in mechanically ventilated spaces with design occupant densities greater than or equal to 25 people per 1000 square feet. For naturally ventilated spaces, CO_2 concentrations should be monitored within all spaces. CO_2 monitoring shall be located within the room between 3 feet and 6 feet above the floor. One CO_2 sensor may be used to represent multiple spaces if the natural ventilation design uses passive stack(s) or other means to induce airflow through those spaces equally and simultaneously without intervention by building occupants.

Measurement of temperature, relative humidity, and dew point can help identify conditions that can lead to condensation and potential mold problems within the building shell.

Calibration of all monitoring system equipment is critically important, and should be done at least as often as the manufacturer recommends.

Section 16a-38k-4 (b)(2): Provide increased outdoor ventilation by designing mechanical ventilation systems to exceed the minimum rates required by the current Connecticut State Building Code or the most recent version of the ASHRAE Standard 62.1 , whichever is more stringent, by thirty percent.

Compliance Assistance for Optional Strategy (b)(2)

If appropriate, use heat recovery equipment to minimize the additional energy consumption associated with higher ventilation rates in mechanical systems.

Section 16a-38k-4 (b)(3): After construction ends and with all interior finishes installed but prior to building occupancy, flush the building continuously for at least ten days with outside air while maintaining an internal temperature between 60°F and 78°F and relative humidity no higher than 60%. Do not "bake out" the building by increasing the temperature of the space. Alternatively, use the following strategy: Flush out each space separately until 3,500 cubic feet of outside air per square foot of floor space has been delivered to that space. The space shall then be ventilated at the rate of 0.3 cubic feet per minute per square foot of floor space or the design minimum outside air rate, whichever is greater. This shall be performed for a minimum of three hours prior to occupancy and then during occupancy until a total of 14,000 cubic feet of outside air per square foot of floor area has been delivered to that space.

Compliance Assistance for Optional Strategy (b)(3)

Perform a building flush-out by supplying outside air continuously for ten days while maintaining an internal temperature of at least 60˚F but no warmer than 78°Fand relative humidity no higher than 60%.

OR

Alternative Compliance Pathway for Optional Strategy (b)(3)

Flush out each space separately with outside air until 3,500 cubic feet of outside air has been delivered for each square foot of floor area. Then ventilate the area at the rate of 0.3 cubic feet of outside air per square foot of floor space or the design outside air rate, whichever is greater, at least three hours prior to occupancy. Maintain that ventilation rate until a total of 14,000 cubic feet of outside air per square foot of floor areas has been delivered to the space.

Section 16a-38k-4 (b)(4): Adhesives and sealants used in the interior of the building shall be certified for low emissions of volatile organic compounds (VOCs) using specifications or certification programs listed in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.*

Section 16a-38k-4 (b)(5): Paints and coatings used in the interior of the building shall be certified for low emissions of volatile organic compounds (VOCs) using specifications or certification programs listed in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings.*

Compliance Assistance for Optional Strategies (b)(4) and (b)(5)

Products shall meet the testing and product requirements of the California Department of Health Services *Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers*, including 2004 Addenda.

OR

Alternative Compliance Pathway for Optional Strategies (b)(4) and (b)(5)

Products shall be certified as low VOC products by one of the programs listed below:

- ❑ Scientific Certification Systems - Indoor Advantage-Gold
- ❑ GREENGUARD Certification Program

Resources

- ❑ Scientific Certification Systems: http://www.scscertified.com/ecoproducts/index.html
- ❑ Greenguard Environmental Institute: http://www.greenguard.org/
- ❑ California Indoor Air Quality Program (for download of the *Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers:* http://www.cal-iaq.org/VOC/

Section 16a-38k-4(b)(6): All carpet, carpet adhesive products and carpet cushion installed in the building interior shall meet current testing and product requirements of the Carpet and Rug Institute's Green Label Plus program.

Compliance Assistance Optional Strategy (b)(6)

The carpet and rug institute maintains a list of qualifying products: http://www.carpet-rug.org/

Section 16a-38k-4(b)(7): All composite wood and agrifiber products used within the shell of the building shall meet the testing and product requirements of the California Department of Health Services *Standard Practice for the Testing of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers,* including 2004 Addenda.

Compliance Assistance for Optional Strategy (b)(7)

The State of California has a downloadable version of the *Standard Practice for the Testing of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers,* including 2004 Addenda at http://www.cal-iaq.org/VOC/

Section 16a-38k-4(b)(8): To protect building occupants from potentially hazardous particulates and pollutants, building design shall control entry of pollutants and excess moisture into buildings and later cross-contamination of regularly occupied areas at all entries directly connecting to the outdoors through the use of permanent entryway systems to capture, dirt, particulates, and moisture. Such entryway systems shall be a minimum of six feet long and may be permanently installed grates, grills, or slotted systems that allow for cleaning underneath. Outside air intakes shall be located a minimum of twenty-five feet from any hazard or noxious contaminants such as vents, chimneys, plumbing vents, exhaust fans, cooling towers, street alleys, parking lots, loading docks, dumpster areas, or any area where vehicle idling occurs. If locating an air intake within twenty-five feet of a contaminant source is unavoidable, the intake must be located a minimum of ten feet horizontal distance and two feet lower than the contaminant source.

Compliance Assistance for Optional Strategy (b)(8)

Installing permanent architectural entryway systems that are at least six feet long will minimize the transport of dirt, particulates, and moisture into the building.

Locating air intakes away from potential sources of air pollution will help to ensure that indoor air quality is not compromised. If located facing a street or driveway, the 25 foot measurement shall be taken from the centerline of the street or driveway.

Section 16a-38k-4(b)(9): Allow for individual lighting control for 90% or more of the building occupants to allow for adjustments to suit individual tasks and preferences and provide lighting system controllability for all shared multi-occupant spaces to enable lighting adjustment that meets group needs and preferences.

Compliance Assistance for Optional Strategy (b)(9)

This option can be met by specifying the installation of multilevel switching for at least 90% of the occupied spaces. Multilevel switching typically allows 1, 2, or 3 lamps in a 3-lamp fixture to be illuminated. Lighting fixtures that incorporate bi-level, hi/low or continuous dimming ballasts may also be specified to comply with this option.

Section 16a-38k-4(b)(10): Using conditions for thermal comfort described in the current version of the ASHRAE Standard 55, allow for individual thermal comfort control for fifty percent or more of the building occupants to allow for adjustments to suit individual tasks and preferences and provide thermal system comfort controllability for all shared multi-occupant spaces to enable adjustment that meets group needs and preferences.

Compliance Assistance for Optional Strategy (b)(10)

Installing adjustable thermostats in each workspace will comply with this option. Programmable thermostats should be considered for all thermostat installations except work areas that are occupied 24/7.

Section 16a-38k-4(b)(11): Building facility personnel, under direction of the building owner, shall administer an anonymous survey for building occupants within the first twelve months after initial occupancy to assess occupant satisfaction and implement corrective actions for recurrent issues. At minimum, the survey shall cover thermal building comfort, lighting, security issues, indoor air quality, functionality of space, and acoustics. If greater than 20% of the respondents express dissatisfaction with any specific issue, the building owner shall prepare a plan for remedial action.

Section 16a-38k-4(b)(12): Demonstrate through computer software simulations or through recording of indoor light measurements that a minimum illumination level of

twenty-five footcandles has been achieved from daylight in at least 75% of all regularly occupied areas.

Compliance Assistance for Optional Strategy (b)(12)

Most lighting design firms and many electrical engineering firms utilize simulation software to predict daylight levels. Lighting design firms and energy efficiency consulting firms will be able to assist with recording light meters to measure daylight contribution.

Section 16a-38k-4(b)(13): There shall be a direct line of sight to the outdoor environment via window glazing between 2 1/2 and 7 1/2 feet above the finished floor for 70% of all regularly occupied areas.

Compliance Assistance for Optional Strategy (b)(13)

Installing windows at normal window heights in 75% of regularly occupied areas will meet this requirement. Rooms without an exterior wall may be excluded from this calculation.

Section 16a-38k-4(b)(14): Where chemical use occurs, including housekeeping areas, chemical storage and mixing areas, and copy/print rooms, use dedicated exhaust to ventilate the space at a minimum of 0.5 cubic feet per minute per square foot with adequate make-up air. No recirculation is permitted and such spaces shall have a negative air pressure of at least five pascal (.02 inches of water gauge) to a minimum of one pascal (0.004 inches of water gauge) when the doors are closed.

Compliance Assistance for Optional Strategy (b)(14)

Physically isolate activities and storage areas that are associated with emissions of hazardous or potentially hazardous contaminants. Design chemical storage and mixing areas and copy rooms with dedicated exhaust ventilation systems.

Additional Indoor Environment Considerations

The following list represents practices that are not specifically addressed in the above sections, but nevertheless will result in creating better indoor air quality in a facility.

- ❑ Avoid pilot lights and install only electric ignitions for gas-fired appliances.
- ❑ Do not use fossil-fuel-powered, mobile, machinery inside the building. This is to prevent accumulation of exhaust inside the building from equipment such as polishers and burnishers.

Building Standard Optional Strategies- State Facilities

Water Efficiency

The following four strategies are available for improving water efficiency; at least one option in this category must be selected:

Section 16a-38k-4(c)(1): Same as in Section 16a-38k-3(g), except that the conserving strategies use 30 percent less water in aggregate.

Section 16a-38k-4(c)(2): Reduce by 50 percent the amount of water required for landscaping from a mid-summer baseline usage case. Reductions may be attributed to the use of captured rainwater, recycled waste (grey) water, efficiency of irrigation strategies, and use of drought resistant plant species. This strategy only applies to renovation projects.

Section 16a-38k-4(c)(3): Use landscaping that does not require a permanent irrigation system or uses non-potable water for irrigation. Any system installed for irrigation using potable water shall only be utilized for plant establishment and be removed prior to one year of building occupancy.

Section 16a-38k-4(c)(4): Reduce potable water use by half through water conserving fixtures and/or use of non-potable water using methodologies stated in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings*. This strategy only applies to renovation projects.

Compliance Assistance for Optional Strategies (c)(1) and (c)(4)

Develop a water-use baseline using the same methodology described for the mandatory requirement 16a-38k-3(f) (see page 15 of this document). Careful selection of water-conserving plumbing fixtures, dry fixtures and efficient control technologies will be needed to meet these more stringent water reduction targets. Composting toilet systems, non-water using urinals, and occupant sensors will all help to reduce the potable water demand. Consider reuse of stormwater and greywater for non-potable applications such as toilet and urinal flushing and custodial uses. Check all local and state codes before proceeding with a greywater or stormwater reuse system.

Compliance Assistance for Optional Strategies (c)(2) and (c)(3)

The use of potable water for irrigation can be minimized or eliminated by specifying drought resistive plants and grasses, collecting and using rainwater for irrigation, and/or using highly water-efficient irrigation systems. When specifying water conservative plants, determine soil composition and ensure that existing soils will support the plants to be specified. Consider all operating and maintenance costs of any irrigation equipment specified. If irrigation is necessary, make arrangements to irrigate during morning hours to maximize irrigation benefits and minimize evaporation.

In order to reduce water demand for sewage conveyance and irrigation, rainwater catchment systems with cisterns or underground storage tanks could be used. These supplementary systems can significantly decrease water demand by drawing on stored water instead of municipal water supplies or drinking water wells.

Rainwater catchment systems should be designed with a water storage capacity for sewage conveyance and/or irrigation in typical years under average conditions. In other words, oversizing water storage to meet drought conditions may be costly and could increase maintenance requirements. On the other hand, undersizing storage may simply result in a system that is too small to significantly offset potable water consumption. Rainwater collection and storage systems should be designed to avoid mold growth, bacterial accumulation, and stagnation.

Resources

- ❑ US Environmental Protection Agency: http://www.epa.gov/oaintrnt/water/index.htm
- ❑ State of Connecticut Department of Environmental Protection: http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325520&depNav_GID=1654&depNav=|
- ❑ State of Connecticut Department of Public Health : http://www.dph.state.ct.us/
- ❑ LEED Reference Guide, Water Credit 2: Innovative Waste Water Technologies and Water Credit 1: Water Efficient Landscaping: http://www.usgbc.org/
- ❑ American Water Works Association: http://www.awwa.org/waterwiser/links/index.cfm?LinkCategoryID=6
- ❑ California Urban Water Conservation council: http://www.h2ouse.org/
- ❑ CHPS Best Practices Manual, vol. 2, Guideline SP6: Drought Tolerant and Pest-Resistant Plants, Guideline SP10: Water-Efficient Irrigation Systems, Guideline SP12: Reclaimed Water for Irrigation: http://www.chps.net/
- ❑ The Irrigation Association: http://www.irrigation.org/

Building Standard Optional Strategies- State Facilities

Recycling, Reuse, and Sustainability

The following thirteen strategies are available for improving recycling, reuse, and sustainability. At least two options within this category must be selected:

Section 16a-38k-4 (d)(1): Retain at least 75 percent, by surface area, of an existing building structure, including structural floor and roof decking, exterior framing, and envelope surface, but excluding window assemblies and non-structural roofing material. This strategy only applies to renovation projects.

Section 16a-38k-4 (d)(2): Same as subsection (d)(1) above, except that a total of 95 percent of the building structure is retained. This strategy only applies to renovation projects.

Section 16a-38k-4 (d)(3): Use existing non-structural elements such as interior walls, doors, floor coverings and ceiling systems in at least half (by square footage) of the completed building. This strategy only applies to renovation projects.

Compliance Assistance for Optional Strategies (d)(1) through (d)(3)

Consider reusing existing, previously occupied buildings, including structure, envelope, and elements. Remove any elements that pose a contamination risk to building occupants and upgrade the components that would improve energy and water efficiency such as windows, mechanical systems, and plumbing fixtures

Section 16a-38k-4 (d)(4): Recycle or salvage at least half of non-hazardous construction and demolition debris.

Section 16a-38k-4 (d)(5): Same as subsection (d)(4) above, except that a total of 75 percent of non-hazardous construction and demolition debris is recycled or salvaged.

Compliance Assistance for Optional Strategies (d)(4) and (d)(5)

Establish goals for diversion from disposal in landfills and incinerators and adopt a construction waste management plan to achieve these goals. Consider recycling cardboard, metal, brick, acoustical tile, concrete, plastic, clean wood, glass, gypsum wallboard, carpet, and insulation. Designate a specific area(s) on the construction site for segregated collection of recyclable materials and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organizations and salvage of materials on-site.

Section 16a-38k-4 (d)(6): Use 5 percent of refurbished, salvaged, or reused materials, based on cost of the total value of materials on the project. Only permanently installed materials can be used in calculations.

Section 16a-38k-4 (d)(7): Same as subsection (d)(6) above, except that a total of 10 percent of refurbished, salvaged, or reused materials, based on cost of the total value of materials on the project shall be used.

Compliance Assistance for Optional Strategies (d)(6) and (d)(7)

Identify opportunities to incorporate salvaged materials into building design and research potential material suppliers. Consider salvaged materials such as beams

and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items. Note that mechanical, electrical, and plumbing components and specialty items such as elevators and equipment shall not be included in this calculation. Only include materials permanently installed in the project

Section 16a-38k-4 (d)(8): Use materials where the weighted average of recycled materials content is 10 percent, based on cost, of the total value of the materials in the project. Recycled content value of a material assembly shall be determined by weight. The weighted average shall be determined using the following formula:

Weighted average of recycled materials= % post consumer content + 1/2(% of pre-consumer content).

Section 16a-38k-4 (d)(9): Same as subsection (d)(8) above, except that the weighted average of recycled materials must constitute at least 20 percent, based on cost, of the total value of the materials in the project.

Compliance Assistance for Optional Strategies (d)(8) and (d)(9)

Identify the project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed. Consider a range of environmental, economic, and performance attributes when selecting products and materials.

Post-consumer material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

Pre-consumer material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

Section 16a-38k-4(d)(10): Use a minimum of 10 percent of building materials extracted or manufactured within a five-hundred mile radius of the building site.

Section 16a-38k-4(d)(11): Same as (d)(10) above, except that a minimum of 20 percent of building materials extracted or manufactured within a five-hundred mile radius of the building site shall be used.

Compliance Assistance for Optional Strategies (d)(10) and (d)(11)

Establish a project goal for locally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed. Consider a range of environmental, economic, and performance attributes when selecting products and materials. Note that if only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value. Mechanical, electrical, and plumbing components and specialty items such as elevators and equipment shall not be included in this calculation. Only include materials permanently installed in the project.

Section 16a-38k-4(d)(12): Use building materials and products that are made from plants harvested in a ten-year or shorter cycle. Two and one-half percent of the total value of building materials and products, based on costs, must be used in the project.

Compliance Assistance for Optional Strategy (d)(12)

Establish a project goal for rapidly renewable materials and identify products and suppliers that can support achievement of this goal. Consider materials such as bamboo, wool, cotton insulation, agrifiber, linoleum, wheatboard, strawboard, and cork. During construction, ensure that the specified renewable materials are installed.

Section 16a-38k-4(d)(13): At least half of permanently installed wood and wood-based products shall be certified in accordance with the current Forest Stewardship Council (FSC) principles and criteria.

Compliance Assistance for Optional Strategy (d)(13)

Establish a project goal for FSC-certified wood products and identify suppliers that can achieve this goal. During construction, ensure that the FSC-certified wood products are installed and quantify the total percentage of FSC-certified wood products installed. Note that these components include, but are not limited to, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes. Only include materials permanently installed in the project

Resources

- LEED-NC, Green Building Rating System for New Construction & Major Renovations, version 2.2, October 2005: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220
- Contact the Connecticut DEP for materials and resources reduce/reuse/recycle issues: http://www.ct.gov/dep/cwp/view.asp?a=2714&q=324882&depNav_GID=1645&depNav=|
- DEP main site: http://www.ct.gov/dep
- Regulation relating to recycling in State of Connecticut http://www.cga.ct.gov/2005/pub/Chap446d.htm

Building Standard Optional Strategies- State Facilities

Site Selection and Development

The following fifteen strategies are available for improving the site selection process. A minimum of two options within this category must be selected:

Section 16a-38k-4(e)(1): Construct or renovate the building on a previously developed site and within one-half mile of a residential zone/neighborhood with an average density of ten units per acre net and within one half mile of a minimum of ten basic services as described in the *State Facilities Building Standard Guidelines Compliance Manual for High Performance Buildings* (this document) and with pedestrian access between the building and the services.

Compliance Assistance for Optional Strategy (e)(1)

Building on a previously developed site, renovating an existing building saves valuable open space. Building within ½ mile of a densely populated area will reduce bus and car traffic, encouraging walking and biking to work. Build within ½ mile of 10 of the following basic services:

1. Community Center
2. Post Office
3. Bank
4. Pharmacy
5. Supermarket
6. Convenience Store
7. School
8. Day Care Center
9. Health Care Facility
10. Laundromat or Dry Cleaner
11. Hardware Store
12. Fitness Center
13. Public Park
14. Government Service Building
15. Senior Center
16. Hair Salon/Barber Shop
17. Library
18. Museum

Section 16a-38k-4(e)(2): Develop on a site that is defined as a brownfield by a local, state, or federal government agency. ("Brownfields" are abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contaminations. Environmental concerns should be addressed before building, but builders are encouraged to re-use these sites.)

Compliance Assistance for Optional Strategy (e)(2)

The Connecticut Brownfields Redevelopment Authority (CBRA) operates programs that encourage brownfields redevelopment by reducing costs, eliminating environmental uncertainty and simplifying the regulatory process. They have identified brownfield sites eligible for redevelopment, and offer grants and financing that lower the financial risks and eliminate the legal, regulatory and environmental risks of redevelopment. See the resources section for a link.

Section 16a-38k-4(e)(3): Select a site that has access to public transportation. Public transportation is considered accessible if the site is located within one-third of a mile to an existing commuter rail station or located within one quarter mile of a public commuter bus line.

Compliance Assistance for Optional Strategy (e)(3)

The Connecticut Dept. of Transportation's Public Transportation Division can provide information on train and bus service as well as van pooling and ride sharing programs. A link is listed in the resources section.

Section 16a-38k-4(e)(4): Encourage bicycle transportation by providing secure bicycle racks or storage within five-hundred feet of a building entrance for a minimum of 5 percent of building users at peak times and shower and changing facilities must be provided in the building or within five-hundred feet of the building. For residential buildings, covered storage facilities shall be provided for securing bicycles for a minimum of 15 percent of building occupants.

Compliance Assistance for Optional Strategy (e)(4)

Many companies manufacture heavy duty bike racks designed for schools and commercial buildings. A web-search using the words "bicycle racks parking" will reveal numerous sources. Local bicycle shops may also be able to supply heavy duty racks.

Section 16a-38k-4(e)(5): Encourage the use of low-emitting and fuel efficient vehicles by providing preferred parking for low-emitting and fuel efficient vehicles for 5 percent of the total parking capacity at the site.

Compliance Assistance for Optional Strategy (e)(5)

To comply provide parking close to the building entrance that represents at least 5% of the total parking capacity, assigning these areas for low emission and fuel efficient vehicles only. Low-emitting, fuel-efficient vehicles may include: hybrids and vehicles using bio-diesel, compressed natural gas, or other low-emitting fuel or technology. Simply assigning parking spaces for compact cars does not satisfy the criteria.

Section 16a-38k-4(e)(6): Reduce pollution from single occupancy vehicle use by sizing parking capacity to meet, but not exceed minimum local zoning requirements; provide

designated preferred parking for carpools or vanpools for 5 percent of the total provided parking spaces; and provide infrastructure and support programs to facilitate shared vehicle usage such as ride sharing bulletin boards and shuttle services to mass transit.

Compliance Assistance for Optional Strategy (e)(6)

The Connecticut Dept. of Transportation's Public Transportation Division can provide information on van pooling and ride sharing programs. A link is listed in the resources section.

Section 16a-38k-4(e)(7): Protect existing natural areas or restore damaged areas to promote biodiversity. Any site disturbances shall be limited to no more than forty feet beyond the building perimeter; ten feet beyond surface walkways, patios, surface parking and utilities less than twelve inches in diameter; fifteen feet beyond primary roadway curbs and main utility branch trenches; and twenty-five feet beyond constructed areas with permeable surfaces, such as playing fields, that require additional staging areas in order to limit compaction in the constructed area. For previously developed or graded sites, restore or protect to a minimum of 50 percent of the site area, excluding the building footprint, to plant species indigenous to the locality or to cultivars of native plants adapted to the local climate conditions and not considered invasive species or noxious weeds. Except for playing fields and picnic areas, minimize lawn areas to less than 10 percent of the building site landscape.

Compliance Assistance for Optional Strategy (e)(7)

The University of Connecticut Cooperative Extension System can assist with the protection of natural areas, the availability/suitability of native plants, water conserving grasses and a wealth of related information on sustainable site design. A link is located in the resource section. Keep lawn areas to less than ten percent of the building site landscape to reduce fuel usage related to mowing.

Section 16a-38k-4(e)(8): Maximize open space at the site. Provide vegetated open space within the project boundary to exceed the local zoning's open space requirement by 25 percent; where there is no local zoning requirement, provide vegetated open space adjacent to the building that, at minimum, is equal to the building footprint.

Compliance Assistance for Optional Strategy (e)(8)

Vegetated open space refers to areas of natural vegetation with native plants. Lawns are not considered "vegetated open space." As with Strategy 7, the University of Connecticut Cooperative Extension System can assist with this strategy.

Section 16a-38k-4(e)(9): Design the site to minimize storm water runoff. Implement a storm water management plan that results in a 25 percent reduction in peak run-off rate for a two year, twenty-four hour storm design from pre-construction to developed conditions; and implement a storm water management plan that results in a 25 percent decrease in run-off volume of storm water runoff from the one hundred-year, twenty-four hour storm design from existing to developed conditions.

Section 16a-38k-4(e)(10): Design the site to minimize pollutants in storm water runoff by implementing a storm water management plan that reduces impervious cover, promotes infiltration, redirects water to pervious areas or storage reservoirs that treats storm water runoff from 90 percent of the average annual rainfall.

Compliance Assistance for Optional Strategies (e)(9)and (e)(10)

Refer to the compliance assistance section for the Erosion and Sedimentation Control requirements (page 18 of this document). A copy of the 2002 Guidelines for Soil Erosion and Sediment Control can be purchased from the Connecticut DEP Inland Water Resources Div. For current information on availability please call (860) 424-3706.

Consider using pervious paving materials to reduce storm water runoff.

Section 16a-38k-4(e)(11): Reduce heat island effect at the site by utilizing any combination of the use of native shade species, paving materials with a solar reflectance index of at least twenty-nine, and/or an open grid pavement system for 50 percent or more of the site parking, sidewalk and road areas; or place at least 50 percent of parking spaces under a covering, such as the a deck, a roof, underground or the building itself. Any roof used to cover parking spaces must have a solar reflectance index of at least twenty-nine.

Section 16a-38k-4(e)(12): Reduce heat island effect through roofing selection by either installing native vegetation on at least 50 percent of the roof area or by using a roofing material that has a Solar Reflectance Index equal to or greater than the values in the following table on at least 75 percent of the roof surface:

Roof Type	**Slope**	**Solar Reflectance Index**
Low-Sloped Roof	**≤ 2:12**	**78**
Steep-Sloped Roof	**> 2:12**	**29**

Compliance Assistance for Optional Strategies (e)(11)and (e)(12)

Materials with dark surfaces (pavement, roofing, etc.) absorb heat and radiate it back to surrounding areas. Studies have demonstrated that where there are many heat absorbing surfaces, temperatures may be boosted by 10˚F or more. The heat island effect increases the need for air conditioning (and therefore electricity consumption) and is detrimental to site plantings, local wildlife, and maintaining comfortable temperatures. The Cool Roof Rating Council can provide information on roofing materials, while the U.S. EPA provides information, including study results, on the heat island effects. See the resource section for links.

Section 16a-38k-4(e)(13): Reduce light pollution from the site. In addition to requirements mandated in Section 4b-16 of the Connecticut General Statutes,

automatic controls to turn off lights during non-business hours shall be installed on all non-emergency interior lighting. Manual override capability may be provided for after hours use. Exterior lighting shall be provided only in areas where lighting is required for safety and comfort. Light fixtures shall not be installed where the main purpose is to light building facades or landscape features. Exterior building-mounted lighting fixtures that are only needed during building operation shall be controlled by a time-clock with an easily accessible manual control. Lighting of flags, signs, and monuments shall be limited to fifty watts per fixture and shall incorporate shielding devices to minimize light pollution. No more than two fixtures may be used for each flag, sign or monument.

Compliance Assistance for Optional Strategy (e)(13)

Section 4b-16 of the Connecticut General Statutes governs outdoor lighting for public facilities, reducing light pollution by controlling the amount and distribution of outdoor lighting. The measures listed above will further assure that the project does not unnecessarily contribute to light pollution. The International Dark-Sky Association is the recognized authority on outdoor light pollution. There is a link in the resources section.

Section 16a-38k-4(e)(14): Building orientation shall be such that the east/west glazing exposure is minimized. South windows shall have an external overhang to entirely shade adjacent windows during the summer solstice or shall utilize glazing with a solar heat gain coefficient of less than or equal to 0.4. Shading mechanisms or glazing with a solar heat gain coefficient less than or equal to 0.4 shall be installed at eastern and western exposure windows to minimize solar heat gain early and late in the day respectively.

Compliance Assistance for Optional Strategy (e)(14)

Orienting a building such that the east/west exposure is minimized and the north/south exposure is maximized provides for optimized daylighting opportunities. Excess glare and heat gain can be controlled by incorporating glazing with a low Solar Heat Gain Coefficient and/or by providing proper shading. South side external overhangs as an architectural feature can be used to shade windows from glare and heat gain. For east and west exposure windows, internal shades can be used to reduce glare and heat gain during the morning and afternoon portions of the day.

Section 16a-38-4(e)(15) Buildings, roads, parking areas, sidewalks, or other impervious surfaces shall not be built in any area that is inconsistent with the state plan of conservation and development.

Compliance Assistance for Optional Strategy (e)(15)

The intent of this option is to address human resource needs and development; balance economic growth with environmental protection and resource conservation concerns; and coordinate the functional planning activities of state

agencies to accomplish long-term effectiveness and economies in the expenditure of public funds. The policies contained in the C&D Plan text provide the context and direction for state agencies to implement their plans and actions in a manner consistent with the following six Growth Management Principles:

1) Redevelop and Revitalize Regional Centers and Areas with Existing or Currently Planned Physical Infrastructure

2) Expand Housing Opportunities and Design Choices to Accommodate a Variety of Household Types and Needs

3) Concentrate Development Around Transportation Nodes and Along Major Transportation Corridors to Support the Viability of Transportation Options

4) Conserve and Restore the Natural Environment, Cultural and Historical Resources, and Traditional Rural Lands

5) Protect and Ensure the Integrity of Environmental Assets Critical to Public Health and Safety

6) Promote Integrated Planning Across all Levels of Government to Address Issues on a Statewide, Regional and Local Basis

Demonstrate within the agency's Environmental Impact Evaluation (EIE) that the project development is consistent with the state plan of conservation and development. The appropriate section of the EIE should be included with the report that is required to be submitted upon design development completion.

Resources

- *CHPS Best Practices Manual*, vol. 2, Guideline GC4, http://www.chps.net/
- *LEED Reference Guide*, Site Prerequisites, http://www.usgbc.org/
- Information on cool roofs is available from the Cool Roof Rating Council website: www.coolroofs.org.
- Information on light pollution:
- Illuminating Engineering Society of North America, http://www.iesna.org/
- *CHPS Best Practices Manual*, vol. 2, EL11: Outdoor Lighting, http://www.chps.net/
- *LEED Reference Guide*, Site Credit 8: Light Pollution Reduction, http://www.usgbc.org/
- The International Dark Sky Association, http://www.darksky.org
- The Connecticut Brownfields Redevelopment Authority: http://www.ctbrownfields.com/
- The Connecticut Dept. of Transportation's Public Transportation Division: http://www.ctrides.com/
- The University of Connecticut Cooperative Extension Service: http://www.extension.uconn.edu/
- Cool Roof Rating Council website: www.coolroofs.org.
- U.S. EPA Heat Island Effect information: http://www.epa.gov/heatisland/

- The International Dark-Sky Association: http://www.darksky.org/
- The Lighting Research Center at RPI Daylighting Program: http://www.lrc.rpi.edu/programs/daylightdividends/
- The National Institute of Building Sciences Daylighting Program: http://www.wbdg.org/design/daylighting.php
- The Daylighting Collaborative: http://www.daylighting.org/
- Daylighting Studies Concerning Productivity: http://www.h-m-g.com/projects/daylighting/projects-PIER.htm
- The state plan for conservation and development is available at http://www.ct.gov/opm/cwp/view.asp?a=2990&q=383182&opmNav_GID=1807
- Connecticut Department of Environmental Protection main site: www.ct.gov/dep
- Center for Land Use Education and Research (CLEAR) and Nonpoint Education for Municipal Officials (NEMO), "Reducing Runoff Through Better Site Design" http://nemo.uconn.edu/tools/stormwater
- Maps of 100-year floodplain elevations are available from FEMA http://www.msc.fema.gov, or call 877-336-2627.
- The Connecticut Locational Guide Map provides information on preserved lands: http://www.ct.gov/opm/cwp/view.asp?a=29908&q=385462&opmNav_GID=1807

Information on stormwater issues:

- U.S. Environmental Protection Agency Stormwater Management for Construction Activities, http://cfpub.epa.gov/npdes/stormwater/swppp.cfm
- U.S. Environmental Protection Agency Construction General Permits, http://cfpub1.epa.gov/npdes/stormwater/cgp.cfm

Building Standard Optional Strategies- State Facilities

Operations and Procedures/Innovation

The following three strategies are available for improving operations or incorporating innovation into the building design. There is no minimum requirement in this category.

Building Standard Optional Strategy

Section 16a-38k-4(f)(1): Do not install fire suppression systems that contain chlorofluorocarbons (CFCs), hydrochlorofluorocarbon (HCFCs), or halons. Select refrigerants and heating, ventilating, air conditioning, and refrigeration (HVAC&R) systems that minimize or eliminate compounds contributing to ozone layer depletion and global warming. If refrigerants are used, the mechanical room shall have leak detection equipment installed.

Compliance Assistance for Optional Strategy (f)(1)

Fire Extinguishers - CFC-free dry chemical type fire extinguishers utilize sodium bicarbonate and monammonium phosphate instead of refrigerants and halons.

HVAC&R – This option expands the mandatory requirement of eliminating CFCs to require that alternative refrigerants-HCFCs or HFCs-meet or exceed the criteria set forth in *LEED for Schools First Edition updated November 2007* under Credit EA 4 Enhanced Refrigeration Management, using the formula under Option 2. Whenever refrigerants are used, mechanical rooms must have leak detection equipment installed. (see also page 23 of this document).

Resources

- The United States Environmental Protection Agency (EPA) has information regarding the benefits of CFC phase out: http://www.epa.gov/ozone/geninfo/benefits.html . An additional EPA resource regarding refrigerants can be found at http://www.epa.gov/ozone/snap/refrigerants/qa.html#middle
- The Global Monitoring Division of the National Oceanic and Atmospheric Administration (NOAA) provides extensive information on ozone depletion and refrigerants: http://www.esrl.noaa.gov/gmd/
- This excellent Princeton University website provides information on ozone depletion and extensive information of CFC alternatives: http://www.princeton.edu/~chm333/2002/spring/Ozone/
- The Alternative Fluorocarbons Environmental Acceptability Study provides information on CFC and HCFC alternatives: http://www.afeas.org/atmospheric_chlorine.html
- In addition to the resources listed above, the EPA maintains information concerning fire extinguisher alternatives at: http://www.epa.gov/ozone/snap/fire/index.html
- The U. S. Green Building Council *LEED for Schools First Edition updated November 2007* can be accessed at http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1586

Section 16a-38k-4 (f)(2): Utilize innovative high performance features or technologies that greatly exceed any existing mandatory requirement as specified in Section 16a-38k-3 or optional measure within Section 16a-38k-4.

Compliance Assistance for Optional Strategy (f)(2)

The purpose of this option is to acknowledge design teams and building owners who adopt innovative high performance features and technologies that greatly exceed existing mandatory measures required under regulation or non-mandatory options within the scope of the regulation. This option recognizes that there are new technologies and new ideas not covered by other options that need to be supported and encouraged.

To achieve credit for achieving this innovation option, submit with the list of measures you intend to implement under the regulation (as required in section 16a-38k-8) a narrative that (1) defines the technology or feature to be utilized and (2) describe how the technology or feature enhances superior performance in the operation of the building.

For the purposes of this option, Combined Heat & Power (CHP) and Geothermal Heat Pump systems are considered advanced technologies that are eligible for credit.

Section 16a-38k-4 (f)(3): In settings where a central plant provides energy to multiple buildings or in cases where multiple buildings are fed from the same fuel source, new construction or renovation shall include metering and other such equipment necessary to evaluate energy and water consumption.

Compliance Assistance for Optional Strategy (f)(3)

When multiple buildings are supplied with electricity from a central meter or receive fuel, steam, or hot water from a central plant, it is impossible to monitor energy consumption for each building. The purpose of this measure is to isolate the consumption of the building so that its performance can be monitored and evaluated. In order to meet this requirement, one of the following strategies should be utilized:

1. **Electric Metering** – Each building should be metered individually. This is a code requirement for new construction. For existing buildings, primary meters can usually be easily installed for each building, or a sub-metering system can be installed. The electric supplier and/or an electrical contractor should be consulted.
2. **Fuel and Steam Metering** – If the building is fed steam or fuel from a central plant, a recording flow meter must be installed that will allow the monitoring of consumption. The fuel supplier and/or a plumbing and heating contractor should be consulted.
3. **Water Metering** – Each building must have a water meter that allows the monitoring of water consumption. The local water district or a plumbing contractor can provide guidance.

Acoustical Standards

Mandatory Requirement for Schools

Mandatory Requirement Section 16a-38k-5(a)	All classrooms, including art rooms, music rooms, science rooms, computer rooms, and special needs, remedial and library space shall meet the acoustical standards as required under section 10-285g of the Connecticut General Statutes.

Purpose

Excessive noise from outside sources, adjacent rooms, or noisy HVAC systems reduces the effectiveness of the learning environment. In extreme cases, it can make it impossible for teachers and students to effectively communicate. This measure ensures that the classroom is an effective learning space.

Compliance Assistance for Mandatory Requirement

Section 10-285g of the Connecticut General Statutes requires school buildings to be constructed or altered in accordance with the American National Standard Institute: Acoustic Performance Criteria, ANSI S12.60-2002, Design Requirements and Guidelines for Schools.

Resources

- American National Standards Institute (ANSI): http://www.ansi.org/
- Acoustical Society of America: http://asa.aip.org/
- Connecticut General Statutes: http://www.cga.ct.gov/

Properly Locate Outside Air Intakes

Mandatory Requirement for Schools

Mandatory Requirement Section 16a-38k-5(b)	Outside air intakes shall be located a minimum of twenty-five feet from any hazard or noxious contaminants such as vents, chimneys, plumbing vents, exhaust fans, cooling towers, street alleys, parking lots, loading docks, dumpster areas, bus loops, or any area where vehicle idling occurs. If locating an air intake within twenty-five feet of a contaminant source is unavoidable, the intake must be located a minimum of ten feet horizontal distance and two feet lower than the contaminant source.

Purpose

Particulates tracked into school buildings are one of the sources of moisture and contaminants in schools. Pesticides, dust, and heavy metals are among the unwanted materials that can be tracked into a building. Poorly placed intake vents are another source of potentially hazardous pollutants into a building.

Compliance Assistance for Mandatory Requirement

Install a permanent architectural entryway system, including a 15 foot walk-off mat, to minimize the transport of dirt, particulates, and moisture into the building.

Locate all air intakes away from potential sources of air pollutants to ensure that indoor air quality is not compromised. Be particularly careful not to locate air intakes near any area where school buses may be idling. If located facing a street or driveway, the 25 foot measurement shall be taken from the center line of the street.

If an air intake is within 25 feet of pollutant sources, show that it is located at least two feet below the contaminant sources and at least ten feed away horizontally from the nearest edge of the air intake to the nearest edge of the contaminant source.

Resources

- ❑ International Code Council, Building Officials and Code Administration (BOCA): http://www.iccsafe.org/help/redirect-bocai.html

Install Gas Equipment with Electronic Ignition

Mandatory Requirement for Schools

Mandatory Requirement Section 16a-38k-5(c)	Only electronic ignitions shall be specified for gas-fired water heaters, boilers, furnaces, air handling units, and stovetops/ovens.

Purpose

Under certain conditions, carbon monoxide from pilot light combustion can accumulate and can cause potentially dangerous conditions for the building occupants.

Compliance Assistance for Mandatory Requirement

Only install gas equipment listed in the mandatory requirement that utilizes electronic ignition.

Use Low VOC Materials

Mandatory Requirement for Schools

Mandatory Requirement Section 16a-38k-5(d)	The following materials shall be certified for low emissions of volatile organic compounds (VOCs) using specifications or certification programs listed in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings*: (1) 50% of adhesives and sealants used in the interior of the building; (2) Acoustic ceiling tiles and wall panels; (3) Interior paints; (4) Wall coverings; (5) Carpet systems and associated adhesives; (6) Composite and solid wood flooring; (7) Resilient flooring and associated adhesives.

Purpose

Volatile Organic Compounds (VOCs) are present to varying degrees in a wide range of common building products. These chemicals can be released into the air and can cause a variety of health problems, from minor irritation to major health issues. Children are typically more susceptible than adults to VOCs

Compliance Assistance for Mandatory Requirement

Purchase and use only products listed that are certified as low-VOC products by one of the following organizations:

- ❑ Scientific Certification Systems - Indoor Advantage-Gold
- ❑ GREENGUARD Certification Program

Resources

- ❑ Scientific Certification Systems: http://www.scscertified.com/ecoproducts/index.html
- ❑ Greenguard Environmental Institute: http://www.greenguard.org/
- ❑ California Indoor Air Quality Program (for download of the *Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers:* http://www.cal-iaq.org/VOC/

Environmental Assessment of Building Site

Mandatory Requirement for Schools

Mandatory Requirement Section 16a-38k-5(e)	The town or regional board of education and the building committee of such town or district, shall provide for a Phase I environmental site assessment in accordance with the American Society for Testing and Materials Standard #1527, Standard Practice for Environmental Site Assessments: Phase I Site Assessment Process, or similar subsequent standards, as required pursuant to Section 10-291 of the Connecticut General Statutes. If a town, regional board of education or the building committee of such town or district suspect contamination, a Phase II Environmental Site Assessment shall be undertaken as described in American Society for Testing and Materials Standard E1903-97 or similar subsequent standards. Any contamination found shall be remedied.

Purpose

To protect children's health, this mandatory measure ensures that the site has been assessed for contamination, and if contamination is suspected, the situation is further investigated and is remedied if necessary.

Compliance Assistance for Mandatory Requirement

Using the Connecticut Department of Environmental Protection's (CT DEP's) Site Characterization Guidance Document (SCGD), conduct a Phase I Environmental Site Assessment (ESA) to determine if contamination exists at the site. As directed in the SCGD, a Phase I ESA must include the following components: site description; site history; file and record reviews of federal, state, and local agencies; review of previous assessments/documentation; the environmental setting; a site reconnaissance survey; and documentation of findings and a preliminary conceptual site model. A variety of information sources may be available to develop the Phase I ESA. These elements are described in detail in the SCGD. A Phase I ESA should be prepared by a CT Licensed Site Professional (LEP). LEPs are licensed by CT DEP to perform investigation and remediation activities on contaminated sites in CT. In addition, towns and/or Boards of Education should receive assistance from the LEP in interpreting the findings, conclusions and recommendations contained in the Phase I ESA.

If the Phase I ESA concludes that any hazardous wastes and/or hazardous substances may be present on the site, a Phase II Environmental Site Assessment must be conducted in accordance with the SCGD. The Phase II ESA should also be performed by an LEP and the LEP should provide the town and/or Board of Education with assistance in interpreting the report's findings, conclusions and recommendations. Any contamination found shall be remedied to meet Connecticut Department of Environmental Protection remediation standard requirements. *Note*

that under the DEP regulation, schools fall into the "residential activity" definition (see Remediation Standard Regulations, definition 53).

Resources

- ❑ Site Characterization Guidance Document: http://www.ct.gov/dep/cwp/view.asp?a=27518&q=335418&depNAV_GID=1626
- ❑ CT Department of Environmental Protection Remediation Standard Regulations: http://www.ct.gov/dep/cwp/view.asp?a=27518&q=325012&depNav_GID=1626
- ❑ CT Department of Environmental Protection Licensed Environmental Professional Program Fact Sheet: http://www.ct.gov/dep/cwp/view.asp?A=2715&Q=324984
- ❑ Roster of Licensed Environmental Professionals in CT: http://www.ct.gov/dep/lib/dep/site_clean_up/lep/LEProster.pdf
- ❑ Environmental Professionals' Organization of Connecticut, Inc.(EPOC) website: http://www.epoc.org/index.php?option=com_wrapper&Itemid=75

HEPA Vacuuming

Mandatory Requirement for Schools

Mandatory Requirement Section 16a-38k-5(f)	Prior to substantial completion of the building, vacuum all carpeted and soft surfaces with a high-efficiency particulate arrestor (HEPA) vacuum. For phased or occupied renovations, HEPA vacuum the carpet daily in occupied areas.

Purpose

This practice minimizes the amount of pollutants that are distributed through the building and retained on surfaces within the building.

Compliance Assistance for Mandatory Requirement

In addition to thorough vacuuming, install carpet and other textile material after all sanding and sawing is complete. If dust producing activities are unavoidable after the installation of carpet/textile material, perform the activities in a contained area and protect all exposed soft surfaces with tape-sealed plastic sheeting.

Building Standard Optional Strategies- Schools

Energy Efficiency and Renewable Energy

The following eleven strategies are available for demonstrating within the energy efficiency and renewable energy category. At least one option in this category must be selected:

Section 16a-38k-6(a)(1): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 3 1/2 percent.

Section 16a-38k-6(a)(2): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 7 percent.

Section 16a-38k-6(a)(3): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 10 1/2 percent.

Section 16a-38k-6(a)(4): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 14 percent.

Section 16a-38k-6(a)(5): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 17 1/2 percent

Section 16a-38k-6(a)(6): Same as in Section 16a-38k-3(c) except that the percentage improvement over base is increased by 21 percent.

Compliance Assistance for Optional Strategies (a)(1) through (a)(6)

The above options use the same compliance methodologies and tools as the requirements outlined in Section 16a-38k-3 (see pages 9 of this document), and they may be used cumulatively. For example, complying with option 3 also puts you in compliance with options 1 and 2 and thus provides 3 (as opposed to just 1) of the 25 total strategies needed for project compliance.

Section 16a-38k-6(a)(7): The installation of on-site renewable energy shall provide at least 3 percent of the building energy needs based upon the U. S. Department of Energy Commercial Buildings Energy Consumption Survey for estimated electricity usage or by using the same modeling software used to demonstrate compliance with the energy efficiency section of this document. Any facility that installs renewable energy systems must retain associated RECs for a period of two years.

Section 16a-38k-6(a)(8): Same as in subsection (a)(7) except at least 7 percent of the building energy needs are met through on-site renewable energy.

Section 16a-38k-6(a)(9): Same as in subsection (a)(7) except at least 10 percent of building energy needs are met through on-site renewable energy.

Compliance Assistance for Optional Strategies (a)(7) through (a)(9)

Renewable energy is classified as:

- ❑ Solar thermal systems
- ❑ Solar electric (photovoltaic systems)
- ❑ Wind power
- ❑ Methane landfill gas

- ❑ Low-impact hydropower (free-flow/no-head, or low-head systems)
- ❑ Biomass from locally available sources
- ❑ Biodiesel
- ❑ Fuel Cells

Geothermal heat pumps are not considered renewable energy systems for the purposes of this option. See "Building Innovations"

Solar thermal systems often offer the best investment in solar energy. Meeting a portion of the building's space heating, domestic water heating, or both loads combined is possible with a variety of system types and configurations. Systems dedicated to domestic water heating needs are often a good choice, as there is a demand for hot water year round.

Photovoltaic systems collect solar energy and directly convert it to electricity. The electricity generated is direct current (DC) and is either used to power DC devices or, more commonly, is converted (inverted) to alternating current (AC) to be used on-site for AC devices and/or supplied to the local electrical grid. Building and ground mounted systems are available.

Wind energy has been rapidly gaining in popularity, and many countries now meet significant portions of their electrical needs with wind generators. Today's slow rpm generators have solved many of the maintenance concerns and have greatly reduced the negative effects on bird life. The siting of wind generators is a long-term process, so planning must begin early. It is not unusual for the available wind to be monitored for at least a one-year period before selecting a site.

Methane landfill gas can be used to directly power boilers or may be used as a fuel source for fuel cells. The gas is corrosive so precautions must be taken to protect system components.

Low-impact hydroelectric power systems take advantage of the natural flow of rivers and streams, rather than utilizing dams to control the flow of water.

Qualifying biomass energy systems use locally grown biomass that is cultivated and harvested in a sustainable manner. Waste wood products and/or wood products from sustainable practices are eligible fuel sources.
Biodiesel is a fuel made from plant materials and/or waste cooking oils. Most commercially available biodiesel is produced from soybeans. Various biodiesel products are available including 100% biodiesel (commonly referred to as B100). Fuel mixes of biodiesel and conventional diesel are also commercially available including B20, B50, and B80 with 20%, 50%, and 80% biodiesel content respectively. In calculating the percentage of renewable energy utilized at the facility, only the actual biodiesel content is to be included. For example, if 10% of the energy is supplied by B50 biodiesel, the renewable contribution to the total energy consumption is 5%.

Resources

- ❑ General information and links to Connecticut Clean Energy Fund: www.ctcleanenergy.com
- ❑ Resources for building modeling software: http://www.eere.energy.gov/buildings/highperformance/simulation_software.html
- ❑ Database of state incentives for renewable energy and efficiency: http://www.dsireusa.org/

- U. S. Department of Energy Commercial Buildings Energy Consumption Surveys: http://www.eia.doe.gov/emeu/consumption/index.html
- CHPS Best Practices Manual, vol. 2: Guideline OS1: http://www.chps.net/
- LEED Reference Guide, Energy and Atmosphere Credit 2: Renewable Energy: http://www.usgbc.org/
- Advanced Buildings Reference Guide: Renewable Energy: http://www.poweryourdesign.com/refguide.htm

Renewable Energy Credit (REC) Options

Section 16a-38k-6(a)(10): The facility shall have a two-year contract to purchase at least 35 percent of the building's annual electricity consumption from a Class I renewable energy source. Alternately, the purchase may be in the form of New England Power Pool Generation Information System (NEPOOL-GIS) renewable energy credits (RECs); if procuring RECs outside of the NEPOOL-GIS, the RECs shall be equivalent to Class I renewable energy source and certified by a nationally recognized certification organization as identified in the *Connecticut State Facilities Building Standard Guidelines Compliance Manual for High Performance Buildings*; or the purchase may be through the CTCleanEnergyOptions™ program . Baseline electric usage can be determined using either the U. S. Department of Energy Commercial Buildings Energy Consumption survey for estimated electricity usage or by using building modeling software that is identified in the *Connecticut State Facilities Building Standard Guidelines Compliance Manual for High Performance Buildings.* RECs purchased to comply with this section cannot be purchased from a facility that has installed renewable energy systems for credit under 16a-38k-4(a)(7 through 9).

Compliance Assistance for Optional Strategy (a)(10)

Determine the energy needs of the building and comply with one of the following three methodologies:

1. Sign a two-year contract with a clean energy provider to purchase renewable energy credits representing at least 35% of the building's annual electricity consumption from a Class 1 renewable energy source. Connecticut Light and Power (CL&P) and United Illuminating (UI) both offer clean energy contracts. See the resources section for more information.

Class I renewable energy source is defined as energy derived from:

- Solar power
- Wind power
- Fuel cells
- Methane gas from landfills
- Ocean thermal power
- Wave or tidal power
- Low emission advanced renewable energy conversion technologies

- ❑ Waste heat recovery systems installed on or after July 1, 2006, that produce electrical or thermal energy by capturing preexisting waste heat or pressure from industrial or commercial processes
- ❑ Run-of-the-river hydropower facilities with generating capacities of not more than five megawatts, do not cause an appreciable change in the river flow, and began operation after July 1, 2003
- ❑ Biomass facilities, including, but not limited to, biomass gasification plants that utilize land clearing debris, tree stumps, or other biomass that regenerates and/or will not result in a depletion of resources, provided such biomass is cultivated and harvested in a sustainable manner and the average emission rate for such facility is equal to or less than .075 pounds of nitrogen oxide per million Btu of heat input for the previous calendar quarter, except that energy derived from a biomass facility with a capacity of less than five hundred kilowatts that began construction before July 1, 2003, may be considered a Class I renewable energy source, provided such biomass is cultivated and harvested in a sustainable manner. (NOTE: Sustainable biomass does not mean construction and demolition waste, finished biomass products from sawmills, paper mills or stud mills, organic refuse derived separately from municipal solid waste, or biomass from old growth timer stands.)

2. Purchase Class 1 renewable energy credits through the New England Power Pool Generation Information System (NEPOOL-GIS) equal to at least 35% of the building's annual electricity consumption. The credits are offered through brokers. See the resources section for a link to NEPOOL certificate brokers.

3. Purchase renewable energy credits through an independent source. The credits must be equivalent to Class I renewable resources and certified by a nationally recognized certification organization such as the Green-e Program offered by the Center for Resource Solutions. See the resources section for a link to the Green-e certificate program.

Renewable Energy Credits

Renewable Energy Credits (RECs) also known as Tradable Renewable Certificates (TRCs) allow a user of electricity to purchase credits for the production of renewable energy that offsets the generation of electricity by conventional means. This allows purchasers to participate in the renewable energy marketplace when locally produced renewable energy is not available. The purchase of RECs allows renewable energy generating facilities to be built where they are most cost-effective, while allowing customers anywhere to participate.

RECs may have monetary value and can be traded on the open market. Participants purchasing RECs to meet the requirements of this regulation may not sell the RECs unless meeting the renewable energy requirement through an alternative method.

Resources

- ❑ Renewable energy credit (REC) New England Power Pool (NEPOOL) program: http://www.nepoolgis.com/
- ❑ Renewable energy credit (REC) Certificate Brokers NEPOOL program: http://www.nepoolgis.com/newsRoom/update02.asp

- Green-e renewable energy credit (REC) purchasing and certification program: http://www.green-e.org/base/re_products?cust=b
- The following article describes the NEPOOL REC system as it applies to the State of Connecticut: http://www.evomarkets.com/assets/evobriefs/nw_1062599800.pdf
- Details of the CT Clean Choice™ clean energy program offered by the DPUC-for customers of CL&P and UI can be found at: http://www.sterlingplanet.com/bizBuyCT.php
- Details of the Community Energy clean energy program offered by the DPUC-for customers of CL&P and UI can be found at: http://www.newwindenergy.com/
- CL&P's clean energy program information is available at: http://www.cl-p.com/community/environment/clean.asp
- Information on UI's clean energy program can be found at: http://www.uinet.com/index.asp

Energy Resource Management: The following strategy is available for renewable and non-renewable energy consumption.

Section 16a-38k-6(a)(11): Develop a measurement and verification plan for energy usage, to cover a period of at least one year after occupancy.

Compliance Assistance for Optional Strategy (a)(11)

This point can be obtained by instituting a plan to monitor and record energy usage for at least one year. A variety of data logging equipment and services are available for the measurement and verification (M&V) of the energy consumption of various systems throughout the building. Contact your electric and gas suppliers for assistance with establishing an M&V process for your facility.

Resources

- Electronic version of the Connecticut State Building Code – Connecticut Supplement is available from the Office of State Building Inspector Web page that can be accessed through the State of Connecticut, Department of Public Safety website: http://www.ct.gov/dps/
- Paper and electronic versions of the Connecticut Building Code (International Building Code Portion of the State Building Code, State of Connecticut) and the International Energy Conservation Code are available from the International Code Council on their website http://www.iccsafe.org under ICC Store and State/Local Codes.
- Main page: http://www.iccsafe.org/

Building Standard Optional Strategies- Schools

Indoor Environment

The following twelve strategies are available for improving indoor environment. At least two options in this category must be selected:

Section 16a-38k-6(b)(1): Install permanent indoor air monitoring systems to provide performance feedback on ventilation systems. Such monitoring systems, at minimum, shall include devices to measure temperature, relative humidity, carbon dioxide, and dew point. Carbon dioxide measurement sensors shall measure both interior and exterior levels of CO2.

Compliance Assistance for Optional Strategy (b)(1)

Air monitoring is an indicator of potential problems within a building. Continuous air sampling allows the building operator to identify potentially unhealthy conditions so that adjustments can be made to resolve the conditions.

According to the LEED New Construction Rating System, carbon dioxide should be monitored in mechanically ventilated spaces with design occupant densities greater than or equal to 25 people per 1000 square feet. For naturally ventilated spaces, CO_2 concentrations should be monitored within all spaces. CO_2 monitoring shall be located within the room between 3 feet and 6 feet above the floor. One CO_2 sensor may be used to represent multiple spaces if the natural ventilation design uses passive stack(s) or other means to induce airflow through those spaces equally and simultaneously without intervention by building occupants.

Measurement of temperature, relative humidity, and dew point can help identify conditions that can lead to condensation and potential mold problems within the building shell.

Calibration of all monitoring system equipment is critically important, and should be done at least as often as the manufacturer recommends.

Section 16a-38k-6 (b)(2): Provide increased outdoor ventilation by designing mechanical ventilation systems to exceed the minimum rates required by the current Connecticut State Building Code or the most recent version of the ASHRAE Standard 62.1 , whichever is more stringent, by thirty percent.

Compliance Assistance for Optional Strategy (b)(2)

If appropriate, use heat recovery equipment to minimize the additional energy consumption associated with higher ventilation rates in mechanical systems.

Section 16a-38k-6 (b)(3): After construction ends and with all interior finishes installed but prior to building occupancy, flush the building continuously for at least ten days with outside air while maintaining an internal temperature between 60°F and 78°F and relative humidity no

higher than 60%. Do not "bake out" the building by increasing the temperature of the space. Alternatively, use the following strategy: Flush out each space separately until 3,500 cubic feet of outside air per square foot of floor space has been delivered to that space. The space shall then be ventilated at the rate of 0.3 cubic feet per minute per square foot of floor space or the design minimum outside air rate, whichever is greater. This shall be performed for a minimum of three hours prior to occupancy and then during occupancy until a total of 14,000 cubic feet of outside air per square foot of floor area has been delivered to that space.

Compliance Assistance for Optional Strategy (b)(3)

Perform a building flush-out by supplying outside air continuously for ten days while maintaining an internal temperature of at least 60˚F but no warmer than 78°Fand relative humidity no higher than 60%.

OR

Alternative Compliance Pathway for Optional Strategy (b)(3)

Flush out each space separately with outside air until 3,500 cubic feet of outside air has been delivered for each square foot of floor area. Then ventilate the area at the rate of 0.3 cubic feet of outside air per square foot of floor space or the design outside air rate, whichever is greater, at least three hours prior to occupancy. Maintain that ventilation rate until a total of 14,000 cubic feet of outside air per square foot of floor areas has been delivered to the space.

Section 16a-38k-6(b)(4): All composite wood and agrifiber products used within the shell of the building shall meet the testing and product requirements of the California Department of Health Services *Standard Practice for the Testing of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers,* including 2004 Addenda.

Compliance Assistance for Optional Strategy (b)(4)

The State of California has a downloadable version of the *Standard Practice for the Testing of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers,* including 2004 Addenda at http://www.cal-iaq.org/VOC/

Section 16a-38k-6(b)(5): For administrative offices and other regularly occupied spaces, allow for individual lighting control for ninety percent or more of the building occupants in workspaces to allow for adjustments to suit individual tasks and preferences. For classroom and core learning spaces, with the exception of chemistry laboratories, art and music rooms, shops, and gyms, install two modes of illumination: general illumination and audio visual illumination. General illumination mode shall achieve desk level illumination of 30-50 footcandles; audio visual mode shall achieve a desk level illumination of 10 to 20 footcandles while limiting vertical illumination at a projection screen of no more than seven footcandles. All lighting fixtures shall include glare control features.

Compliance Assistance for Optional Strategy (b)(5)

This option can be met by specifying the installation of lighting controls for at least 90% of the administrative work spaces. Lighting in all classrooms and learning spaces, with the exception of spaces noted in the regulation, shall have a minimum of two illumination modes: general illumination mode and audio visual mode.

Section 16a-38k-6(b)(6): Using conditions for thermal comfort described in the current version of the ASHRAE Standard 55, allow for individual thermal comfort control for fifty percent or more of the building occupants to allow for adjustments to suit individual tasks and preferences and provide thermal system comfort controllability for all shared multi-occupant spaces to enable adjustment that meets group needs and preferences.

Compliance Assistance for Optional Strategy (b)(6)

Installing adjustable thermostats in each classroom and workspace will comply with this option. Programmable thermostats should be considered for all thermostat installations.

Section 16a-38k-6(b)(7): Building facility personnel, under direction of the building owner, shall administer an anonymous survey for building occupants within the first twelve months after initial occupancy to assess occupant satisfaction and implement corrective actions for recurrent issues. At minimum, the survey shall cover thermal building comfort, lighting, security issues, indoor air quality, functionality of space, and acoustics. If greater than 20% of the respondents express dissatisfaction with any specific issue, the building owner shall prepare a plan for remedial action.

Section 16a-38k-6(b)(8): Demonstrate through computer software simulations or through recording of indoor light measurements that a minimum illumination level of twenty-five footcandles has been achieved from daylight in at least 75% of all regularly occupied areas.

Compliance Assistance for Optional Strategy (b)(8)

Most lighting design firms and many electrical engineering firms utilize simulation software to predict daylight levels. Lighting design firms and energy efficiency consulting firms will be able to assist with recording light meters to measure daylight contribution.

Section 16a-38k-6(b)(9): There shall be a direct line of sight to the outdoor environment via window glazing between 2 1/2 and 7 1/2 feet above the finished floor for 70% of all regularly occupied areas.

Compliance Assistance for Optional Strategy (b)(9)

Installing windows at normal window heights in 75% of regularly occupied areas will meet this requirement. Rooms without an exterior wall may be excluded from this calculation.

Section 16a-38k-6(b)(10): To prevent mold, heating, ventilating and air conditioning systems (HVAC) shall be designed to limit space relative humidity to 60% or less during load conditions whether the building is occupied or non-occupied; an ongoing indoor air quality management plan shall be implemented as required under section 10-220 of the Connecticut General Statutes,

using the U. S. Environmental Protection Agency's (EPA) Indoor Air Quality *Tools for Schools* Program; and the criteria of sections 16a-38k-6(b)(6) and 16a-38k-6(b)(7) of the Regulations of Connecticut State Agencies shall be met.

Compliance Assistance for Optional Strategy (b)(10)

Resources

- ❑ Connecticut General Statutes: http://www.cga.ct.gov/
- ❑ Tools for Schools: http://www.epa.gov/iaq/schools/

Section 16a-38k-6(b)(11): Student and teacher classroom chairs, desks, and tables manufactured, refurbished or refinished within one year prior to building occupancy and used within the building interior shall be certified for low chemical emissions by the certifying organization listed in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings*.

Compliance Assistance for Optional Strategy (b)(11)

Use the following certification organization to identify low VOC furniture:

- ❑ Greenguard Environmental Institute: http://www.greenguard.org/

Alternatively, you may utilize an independent third-party air quality testing laboratory using one of the methodologies described in *LEED 2009 for Schools New Construction and Major Renovations* rating system IEQ Credit 4.5: Furniture and Furnishings OPTION 2 or OPTION 3: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1586#2007

Section 16a-38k-6(b)(12): Where chemical use occurs, including housekeeping areas, chemical storage and mixing areas, and copy/print rooms, use dedicated exhaust to ventilate the space at a minimum of 0.5 cubic feet per minute per square foot with adequate make-up air. No recirculation is permitted and such spaces shall have a negative air pressure of at least five pascal (.02 inches of water gauge) to a minimum of one pascal (0.004 inches of water gauge) when the doors are closed.

Compliance Assistance for Optional Strategy (b)(12)

Physically isolate activities and storage areas that are associated with emissions of hazardous or potentially hazardous contaminants. Design chemical storage and mixing areas and copy rooms with dedicated exhaust ventilation systems.

Section 16a-38k-6(b)(13): Building design shall control entry of pollutants and excess moisture into buildings and later cross-contamination of regularly occupied areas at all high volume entryways and those adjacent to playing fields and locker rooms through the use of three-part walk-off systems and the proper placement of outside air intakes. Walk-off systems shall include a grate or grill outside the entryway for removing dirt and snow, a drop through mat system within the vestibule, and a fifteen foot interior walk-off mat.

Compliance Assistance for Optional Strategy (b)(13)

One of the major sources of particulate contamination in school buildings are particles tracked into schools on shoes. Contaminants include pesticides, heavy metals, and dust. The best way to minimize this unwanted contamination from entering the building is the use of a permanents walk-off entryway system at all entrances in which people normally enter and exit the building . Specifications should include entryway walk-off systems and walk-off mats.

Additional Indoor Environment Considerations

The following practice is not specifically addressed in the above sections, but nevertheless will result in creating better indoor air quality in a facility.

- ❑ Do not use fossil-fuel-powered, mobile, machinery inside the building. This is to prevent accumulation of exhaust inside the building from equipment such as floor polishers and burnishers.

Building Standard Optional Strategies- Schools

Water Efficiency

The following four strategies are available for improving water efficiency; at least one option in this category must be selected:

Section 16a-38k-6(c)(1): Same as in Section 16a-38k-3(g), except that the conserving strategies use 30 percent less water in aggregate.

Section 16a-38k-6(c)(2): Reduce by 50 percent the amount of water required for landscaping from a mid-summer baseline usage case. Reductions may be attributed to the use of captured rainwater, recycled waste (grey) water, efficiency of irrigation strategies, and use of drought resistant plant species. This strategy only applies to renovation projects.

Section 16a-38k-6(c)(3): Use landscaping that does not require a permanent irrigation system or uses non-potable water for irrigation. Any system installed for irrigation using potable water shall only be utilized for plant establishment and be removed prior to one year of building occupancy.

Section 16a-38k-6(c)(4): Reduce potable water use by half through water conserving fixtures and/or use of non-potable water using methodologies stated in the *Connecticut Building Standard Guidelines Compliance Manual for High Performance Buildings*. This strategy only applies to renovation projects.

Compliance Assistance for Optional Strategies (c)(1) and (c)(4)

Develop a water-use baseline using the same methodology described for the mandatory requirement 16a-38k-3(f) (see page 15 of his document). Careful selection of water-conserving plumbing fixtures, dry fixtures and efficient control technologies will be needed to meet these more stringent water reduction targets. Composting toilet systems, non-water using urinals, and occupant sensors will all help to reduce the potable water demand. Consider reuse of stormwater and greywater for non-potable applications such as toilet and urinal flushing and custodial uses. Check all local and state codes before proceeding with a greywater or stormwater reuse system.

Compliance Assistance for Optional Strategies (c)(2) and (c)(3)

The use of potable water for irrigation can be minimized or eliminated by specifying drought resistive plants and grasses, collecting and using rainwater for irrigation, and/or using highly water-efficient irrigation systems. When specifying water conservative plants, determine soil composition and ensure that existing soils will support the plants to be specified. Consider all operating and maintenance costs of any irrigation equipment specified. If irrigation is necessary, make arrangements to irrigate during morning hours to maximize irrigation benefits and minimize evaporation.

In order to reduce water demand for sewage conveyance and irrigation, rainwater catchment systems with cisterns or underground storage tanks could be used. These supplementary systems can significantly decrease water demand by drawing on stored water instead of municipal water supplies or drinking water wells.

Rainwater catchment systems should be designed with a water storage capacity for sewage conveyance and/or irrigation in typical years under average conditions. In other words, oversizing water storage to meet drought conditions may be costly and could increase maintenance requirements. On the other hand, undersizing storage may simply result in a system that is too small to significantly offset potable water consumption. Rainwater collection and storage systems should be designed to avoid mold growth, bacterial accumulation, and stagnation.

Resources

- ❑ US Environmental Protection Agency: http://www.epa.gov/oaintrnt/water/index.htm
- ❑ State of Connecticut Department of Environmental Protection: http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325520&depNav_GID=1654&depNav=|
- ❑ State of Connecticut Department of Public Health : http://www.dph.state.ct.us/
- ❑ LEED Reference Guide, Water Credit 2: Innovative Waste Water Technologies and Water Credit 1: Water Efficient Landscaping: http://www.usgbc.org/
- ❑ American Water Works Association: http://www.awwa.org/waterwiser/links/index.cfm?LinkCategoryID=6
- ❑ California Urban Water Conservation council: http://www.h2ouse.org/
- ❑ CHPS Best Practices Manual, vol. 2, Guideline SP6: Drought Tolerant and Pest-Resistant Plants, Guideline SP10: Water-Efficient Irrigation Systems, Guideline SP12: Reclaimed Water for Irrigation: http://www.chps.net/
- ❑ The Irrigation Association: http://www.irrigation.org/

Building Standard Optional Strategies- Schools

Recycling, Reuse, and Sustainability

The following thirteen strategies are available for improving recycling, reuse, and sustainability. At least two options within this category must be selected:

Section 16a-38k-6(d)(1): Retain at least 75 percent, by surface area, of an existing building structure, including structural floor and roof decking, exterior framing, and envelope surface, but excluding window assemblies and non-structural roofing material. This strategy only applies to renovation projects.

Section 16a-38k-6(d)(2): Same as subsection (d)(1) above, except that a total of 95 percent of the building structure is retained. This strategy only applies to renovation projects.

Section 16a-38k-6(d)(3): Use existing non-structural elements such as interior walls, doors, floor coverings and ceiling systems in at least half (by square footage) of the completed building. This strategy only applies to renovation projects.

Compliance Assistance for Optional Strategies (d)(1) through (d)(3)

Consider reusing existing, previously occupied buildings, including structure, envelope, and elements. Remove any elements that pose a contamination risk to building occupants and upgrade the components that would improve energy and water efficiency such as windows, mechanical systems, and plumbing fixtures

Section 16a-38k-6(d)(4): Recycle or salvage at least half of non-hazardous construction and demolition debris.

Section 16a-38k-6(d)(5): Same as subsection (d)(4) above, except that a total of 75 percent of non-hazardous construction and demolition debris is recycled or salvaged.

Compliance Assistance for Optional Strategies (d)(4) and (d)(5)

Establish goals for diversion from disposal in landfills and incinerators and adopt a construction waste management plan to achieve these goals. Consider recycling cardboard, metal, brick, acoustical tile, concrete, plastic, clean wood, glass, gypsum wallboard, carpet, and insulation. Designate a specific area(s) on the construction site for segregated collection of recyclable materials and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organizations and salvage of materials on-site.

Section 16a-38k-6(d)(6): Use 5 percent of refurbished, salvaged, or reused materials, based on cost of the total value of materials on the project. Only permanently installed materials can be used in calculations.

Section 16a-38k-6(d)(7): Same as subsection (d)(6) above, except that a total of 10 percent of refurbished, salvaged, or reused materials, based on cost of the total value of materials on the project shall be used.

Compliance Assistance for Optional Strategies (d)(6) and (d)(7)

Identify opportunities to incorporate salvaged materials into building design and research potential material suppliers. Consider salvaged materials such as beams and posts,

flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items. Note that mechanical, electrical, and plumbing components and specialty items such as elevators and equipment shall not be included in this calculation. Only include materials permanently installed in the project

Section 16a-38k-6(d)(8): Use materials where the weighted average of recycled materials content is 10 percent, based on cost, of the total value of the materials in the project. Recycled content value of a material assembly shall be determined by weight. The weighted average shall be determined using the following formula:

Weighted average of recycled materials= % post consumer content + 1/2(% of pre-consumer content).

Section 16a-38k-6(d)(9): Same as subsection (d)(8) above, except that the weighted average of recycled materials must constitute at least 20 percent, based on cost, of the total value of the materials in the project.

Compliance Assistance for Optional Strategies (d)(8) and (d)(9)

Identify the project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed. Consider a range of environmental, economic, and performance attributes when selecting products and materials.

Post-consumer material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

Pre-consumer material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

Section 16a-38k-6(d)(10): Use a minimum of 10 percent of building materials extracted or manufactured within a five-hundred mile radius of the building site.

Section 16a-38k-6(d)(11): Same as (d)(10) above, except that a minimum of 20 percent of building materials extracted or manufactured within a five-hundred mile radius of the building site shall be used.

Compliance Assistance for Optional Strategies (d)(10) and (d)(11)

Establish a project goal for locally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed. Consider a range of environmental, economic, and performance attributes when selecting products and materials. Note that if only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value. Mechanical, electrical, and plumbing components and specialty items such as elevators and equipment shall not be included in this calculation. Only include materials permanently installed in the project.

Section 16a-38k-6(d)(12): Use building materials and products that are made from plants harvested in a ten-year or shorter cycle. Two and one-half percent of the total value of building materials and products, based on costs, must be used in the project.

Compliance Assistance for Optional Strategy (d)(12)

Establish a project goal for rapidly renewable materials and identify products and suppliers that can support achievement of this goal. Consider materials such as bamboo, wool, cotton insulation, agrifiber, linoleum, wheatboard, strawboard, and cork. During construction, ensure that the specified renewable materials are installed.

Section 16a-38k-6(d)(13): At least half of permanently installed wood and wood-based products shall be certified in accordance with the current Forest Stewardship Council (FSC) principles and criteria.

Compliance Assistance for Optional Strategy (d)(13)

Establish a project goal for FSC-certified wood products and identify suppliers that can achieve this goal. During construction, ensure that the FSC-certified wood products are installed and quantify the total percentage of FSC-certified wood products installed. Note that these components include, but are not limited to, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes. Only include materials permanently installed in the project

Resources

- LEED for Schools Green Building Rating System for New Construction and Major Renovation, First Edition, November, 2007. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1586
- Contact the Connecticut DEP for materials and resources reduce/reuse/recycle issues: http://www.ct.gov/dep/cwp/view.asp?a=2714&q=324882&depNav_GID=1645&depNav=|
- DEP main site: http://www.ct.gov/dep
- Regulation relating to recycling in State of Connecticut http://www.cga.ct.gov/2005/pub/Chap446d.htm

Building Standard Optional Strategies- Schools

Site Selection and Development

The following fourteen strategies are available for improving the site selection process. A minimum of two options within this category must be selected:

Section 16a-38k-6(e)(1): Construct or renovate the building on a previously developed site and within one-half mile of a residential zone/neighborhood with an average density of ten units per acre net and within one half mile of a minimum of ten basic services as described in the *State Facilities Building Standard Guidelines Compliance Manual for High Performance Buildings* (this document) and with pedestrian access between the building and the services.

Compliance Assistance for Optional Strategy (e)(1)

Building on a previously developed site or renovating an existing building saves valuable open space. Building within ½ mile of a densely populated area will reduce bus and car traffic. Build within ½ mile of 10 of the following basic services:

1. Community Center
2. Post Office
3. Bank
4. Pharmacy
5. Supermarket
6. Convenience Store
7. Public Library
8. Day Care Center
9. Health Care Facility
10. Laundromat or Dry Cleaner
11. Hardware Store
12. Fitness Center
13. Public Park
14. Government Service Building
15. Senior Center
16. Hair Salon/Barber Shop
17. Museum

Section 16a-38k-6(e)(2): Select a site that has access to public transportation. Public transportation is considered accessible if the site is located within one-third of a mile to an existing commuter rail station or located within one quarter mile of a public commuter bus line.

Compliance Assistance for Optional Strategy (e)(2)

The Connecticut Dept. of Transportation's Public Transportation Division can provide information on train and bus services, and ride sharing programs for teachers and staff. A link is listed in the resources section.

Section 16a-38k-6(e)(3) Encourage bicycle transportation by providing secure bicycle racks or storage within five-hundred feet of a building entrance for a minimum of 5 percent of building users at peak times and shower and changing facilities must be provided in the building or within five-hundred feet of the building.

Compliance Assistance for Optional Strategy (e)(3)

Many companies manufacture heavy duty bike racks designed for schools and commercial buildings. A web-search using the words "bicycle racks parking" will reveal numerous sources. Local bicycle shops may also be able to supply heavy duty racks.

Section 16a-38k-6(e)(4): Encourage the use of low-emitting and fuel efficient vehicles by providing preferred parking for low-emitting and fuel efficient vehicles for 5 percent of the total parking capacity at the site.

Compliance Assistance for Optional Strategy (e)(4)

To comply provide parking close to the building entrance that represents at least 5% of the total parking capacity, assigning these areas for low emission and fuel efficient vehicles only. Low-emitting, fuel-efficient vehicles include: electric, hybrids and vehicles using bio-diesel, compressed natural gas, or other low-emitting fuel or technology. Simply assigning parking spaces for compact cars does not satisfy the criteria.

Section 16a-38k-6(e)(5): Reduce pollution from single occupancy vehicle use by sizing parking capacity to meet, but not exceed minimum local zoning requirements; provide designated preferred parking for carpools or vanpools for 5 percent of the total provided parking spaces; and provide infrastructure and support programs to facilitate shared vehicle usage such as ride sharing bulletin boards and shuttle services to mass transit.

Compliance Assistance for Optional Strategy (e)(5)

The Connecticut Dept. of Transportation's Public Transportation Division can provide information on van pooling and ride sharing programs available to teachers and administrative staff. A link is listed in the resources section.

Section 16a-38k-6(e)(6): Protect existing natural areas or restore damaged areas to promote biodiversity. Any site disturbances shall be limited to no more than forty feet beyond the building perimeter; ten feet beyond surface walkways, patios, surface parking and utilities less than twelve inches in diameter; fifteen feet beyond primary roadway curbs and main utility branch trenches; and twenty-five feet beyond constructed areas with permeable surfaces, such as playing fields, that require additional staging areas in order to limit compaction in the constructed area. For previously developed or graded sites, restore or protect to a minimum of 50 percent of the site area, excluding the building footprint, to plant species indigenous to the locality or to cultivars of native plants adapted to the local climate conditions and not considered invasive species or noxious weeds. Except for playing fields and picnic areas, minimize lawn areas to less than 10 percent of the building site landscape.

Compliance Assistance for Optional Strategy (e)(6)

The University of Connecticut Cooperative Extension System can assist with the protection of natural areas, the availability/suitability of native plants, water conserving grasses and a wealth of related information on sustainable site design. A link is located in the resource section. Keep lawn areas to less than ten percent of the building site landscape to reduce fuel usage related to mowing.

Section 16a-38k-6(e)(7): Maximize open space at the site. Provide vegetated open space within the project boundary to exceed the local zoning's open space requirement by 25 percent; where there is no local zoning requirement, provide vegetated open space adjacent to the building that, at minimum, is equal to the building footprint.

Compliance Assistance for Optional Strategy (e)(7)

Vegetated open space refers to areas of natural vegetation with native plants. Lawns are not considered "vegetated open space." As with Strategy 6, the University of Connecticut Cooperative Extension System can assist with this strategy.

Section 16a-38k-6(e)(8): Design the site to minimize storm water runoff. Implement a storm water management plan that results in a 25 percent reduction in peak run-off rate for a two year, twenty-four hour design storm from pre-construction to developed conditions; and implement a storm water management plan that results in a 25 percent decrease in run-off volume of storm water runoff from the one hundred-year, twenty-four hour design storm from existing to developed conditions.

Section 16a-38k-6(e)(9): Design the site to minimize pollutants in storm water runoff by implementing a storm water management plan that reduces impervious cover, promotes infiltration, redirects water to pervious areas or storage reservoirs that treats storm water runoff from 90 percent of the average annual rainfall.

Compliance Assistance for Optional Strategies (e)(8)and (e)(9)

Refer to the compliance assistance section for the Erosion and Sedimentation Control requirements (page 18 in this document). A copy of the 2002 Guidelines for Soil Erosion and Sediment Control can be purchased from the Connecticut DEP Inland Water Resources Div. For current information on availability please call (860) 424-3706.

Consider using pervious paving materials to reduce storm water runoff.

Section 16a-38k-6(e)(10): Reduce heat island effect at the site by utilizing any combination of the use of native shade species, paving materials with a solar reflectance index of at least twenty-nine, and/or an open grid pavement system for 50 percent or more of the site parking, sidewalk and road areas; or place at least 50 percent of parking spaces under a covering, such as the a deck, a roof, underground or the building itself. Any roof used to cover parking spaces must have a solar reflectance index of at least twenty-nine.

Section 16a-38k-6(e)(11): Reduce heat island effect through roofing selection by either installing native vegetation on at least 50 percent of the roof area or by using a roofing material that has a Solar Reflectance Index equal to or greater than the values in the following table on at least 75 percent of the roof surface:

Roof Type	Slope	Solar Reflectance Index
Low-Sloped Roof	**≤ 2:12**	**78**
Steep-Sloped Roof	**> 2:12**	**29**

Compliance Assistance for Optional Strategies (e)(10)and (e)(11)

Materials with dark surfaces (pavement, roofing, etc.) absorb heat and radiate it back to surrounding areas. Studies have demonstrated that where there are many heat absorbing surfaces, temperatures may be boosted by 10˚F or more. The heat island effect increases the need for air conditioning (and therefore electricity consumption) and is detrimental to site plantings, local wildlife, and maintaining comfortable temperatures. The Cool Roof Rating Council can provide information on roofing materials, while the U.S. EPA provides information, including study results, on the heat island effects. See the resource section for links.

Section 16a-38k-6(e)(12): Reduce light pollution from the site. In addition to requirements mandated in Section 4b-16 of the Connecticut General Statutes, automatic controls to turn off lights during non-business hours shall be installed on all non-emergency interior lighting. Manual override capability may be provided for after hours use. Exterior lighting shall be provided only in areas where lighting is required for safety and comfort. Light fixtures shall not be installed where the main purpose is to light building facades or landscape features. Exterior building-mounted lighting fixtures that are only needed during building operation shall be controlled by a time-clock with an easily accessible manual control. Lighting of flags, signs, and monuments shall be limited to fifty watts per fixture and shall incorporate shielding devices to minimize light pollution. No more than two fixtures may be used for each flag, sign or monument.

Compliance Assistance for Optional Strategy (e)(12)

Section 4b-16 of the Connecticut General Statutes governs outdoor lighting for public facilities, reducing light pollution by controlling the amount and distribution of outdoor lighting. The measures listed above will further assure that the project does not unnecessarily contribute to light pollution. The International Dark-Sky Association is the recognized authority on outdoor light pollution. There is a link in the resources section.

Section 16a-38k-6(e)(13): Building orientation shall be such that the east/west glazing exposure is minimized. South windows shall have an external overhang to entirely shade adjacent windows during the summer solstice or shall utilize glazing with a solar heat gain coefficient of less than or equal to 0.4. Shading mechanisms or glazing with a solar heat gain coefficient less than or equal to 0.4 shall be installed at eastern and western exposure windows to minimize solar heat gain early and late in the day respectively.

Compliance Assistance for Optional Strategy (e)(13)

Orienting a building such that the east/west exposure is minimized and the north/south exposure is maximized provides for optimized daylighting opportunities. Excess glare and heat gain can be controlled by incorporating glazing with a low Solar Heat Gain Coefficient and/or by providing proper shading. South side external overhangs as an architectural feature can be used to shade windows from glare and heat gain. For east and west exposure windows, internal shades can be used to reduce glare and heat gain during the morning and afternoon portions of the day.

Section 16a-38-6(e)(14) Buildings shall not be constructed on land that is lower than five feet above the elevation of the 100 year flood as defined by the Federal Emergency Management Agency or its successor agency; and buildings, roads, parking areas, sidewalks, or other impervious surfaces shall not be built in any area that is inconsistent with the applicable municipal plan of conservation and development prepared in accordance with section 8-23 of the Connecticut General Statutes

Compliance Assistance for Optional Strategy (e)(14)

Building on land that is prone to flooding is not only damaging to the environment, but can create moisture problems in a building. Problems can be as severe as periodic flooding or as subtle as moisture migration into the building. Unwanted moisture can result in deterioration of building materials and mold formation. Not developing land on floodplains achieves two important results:

- Decreases in building damage and liability
- Restoration of floodplain land to absorb flood waters and minimize impacts to downstream communities.

This option addresses human resource needs and development and balances economic growth with environmental protection and resource conservation concerns in the expenditure of public funds.

To document compliance, provide the appropriate FEMA map demonstrating that the building is not located in the floodplain, and provide a copy of the municipal plan of conservation and development is available at the office of the town clerk and if the municipality has a website, it is required to be posted on that site.

Section 16a-38-6(e)(15) The school building shall be sited on land away from sources of unreasonable excess noise, such as highways, airport flight paths, and areas that are subject to unreasonable noise from agricultural or industrial equipment use.

Compliance Assistance for Optional Strategy (e)(15)

Avoid building on sites that are subject to excessive exterior noise.

Resources

- *CHPS Best Practices Manual*, vol. 2, Guideline GC4, http://www.chps.net/
- *LEED Reference Guide*, Site Prerequisites, http://www.usgbc.org/
- Information on cool roofs is available from the Cool Roof Rating Council website: www.coolroofs.org.
- Information on light pollution:
- Illuminating Engineering Society of North America, http://www.iesna.org/
- *CHPS Best Practices Manual*, vol. 2, EL11: Outdoor Lighting, http://www.chps.net/
- *LEED Reference Guide*, Site Credit 8: Light Pollution Reduction, http://www.usgbc.org/
- The International Dark Sky Association, http://www.darksky.org
- The Connecticut Dept. of Transportation's Public Transportation Division: http://www.ctrides.com/
- The University of Connecticut Cooperative Extension Service: http://www.extension.uconn.edu/
- Cool Roof Rating Council website: www.coolroofs.org.
- U.S. EPA Heat Island Effect information: http://www.epa.gov/heatisland/
- The International Dark-Sky Association: http://www.darksky.org/
- The Lighting Research Center at RPI Daylighting Program: http://www.lrc.rpi.edu/programs/daylightdividends/
- The National Institute of Building Sciences Daylighting Program: http://www.wbdg.org/design/daylighting.php
- The Daylighting Collaborative: http://www.daylighting.org/
- Daylighting Studies Concerning Productivity: http://www.h-m-g.com/projects/daylighting/projects-PIER.htm
- Connecticut Department of Environmental Protection main site: www.ct.gov/dep
- Center for Land Use Education and Research (CLEAR) and Nonpoint Education for Municipal Officials (NEMO), "Reducing Runoff Through Better Site Design" http://nemo.uconn.edu/tools/stormwater
- Maps of 100-year floodplain elevations are available from FEMA http://www.msc.fema.gov

Information on stormwater issues:

- U.S. Environmental Protection Agency Stormwater Management for Construction Activities, http://cfpub.epa.gov/npdes/stormwater/swppp.cfm
- U.S. Environmental Protection Agency Construction General Permits, http://cfpub1.epa.gov/npdes/stormwater/cgp.cfm
- Municipal websites can be found using the "Quick Links" button at: http://www.ct.gov/
- FEMA maps and Flood Insurance Studies (which contain flood and coastal profiles) are available at: http://www.msc.fema.gov/

Building Standard Optional Strategies- Schools

Operations and Procedures/Innovation

The following three strategies are available for improving operations or incorporating innovation into the building design. There is no minimum requirement in this category.

Building Standard Optional Strategy

Section 16a-38k-6(f)(1): Do not install fire suppression systems that contain chlorofluorocarbons (CFCs), hydrochlorofluorocarbon (HCFCs), or halons. Select refrigerants and heating, ventilating, air conditioning, and refrigeration (HVAC&R) systems that minimize or eliminate compounds contributing to ozone layer depletion and global warming. If refrigerants are used, the mechanical room shall have leak detection equipment installed.

Compliance Assistance for Optional Strategy (f)(1)

Fire Extinguishers - CFC-free dry chemical type fire extinguishers utilize sodium bicarbonate and monammonium phosphate instead of refrigerants and halons.

HVAC&R – This option expands the mandatory requirement of eliminating CFCs to require that alternative refrigerants-HCFCs or HFCs-meet or exceed the criteria set forth in *LEED for Schools First Edition updated November 2007* under Credit EA 4 Enhanced Refrigeration Management, using the formula under Option 2. Whenever refrigerants are used, mechanical rooms must have leak detection equipment installed.

Section 16a-38k-6 (f)(2): Utilize innovative high performance features or technologies that greatly exceed any existing mandatory requirements as specified in sections 16a-38k-3 and 16a-38k-5 or optional measures within Section 16a-38k-6.

Compliance Assistance for Optional Strategy (f)(2)

The purpose of this option is to acknowledge design teams and building owners who adopt innovative high performance features and technologies that greatly exceed existing mandatory measures required under regulation or non-mandatory options within the scope of the regulation. This option recognizes that there are new technologies and new ideas not covered by other options that need to be supported and encouraged.

To achieve credit for achieving this innovation option, submit with the list of measures you intend to implement under the regulation (as required in section 16a-38k-8) a narrative that (1) defines the technology or feature to be utilized and (2) describe how the technology or feature enhances superior performance in the operation of the building.

For the purposes of this option, Combined Heat & Power (CHP) and Geothermal Heat Pump systems are considered advanced technologies that are eligible for credit.

Section 16a-38k-6 (f)(3): Integrate the sustainable features of the school building into the educational curriculum within the first full year of school operation.

Compliance Assistance for Optional Strategy (f)(3)

The design team should coordinate with and educate the school administration and faculty on the high performance features of the school. A curriculum should describe those features and explore the relationships between humans, the building, and the natural environment. The curriculum must include at least ten hours of classroom instruction per year per full-time student, meet state standards and be approved by the school administrators

Resources

- ❑ The United States Environmental Protection Agency (EPA) has information regarding the benefits of CFC phase out: http://www.epa.gov/ozone/geninfo/benefits.html . An additional EPA resource regarding refrigerants can be found at http://www.epa.gov/ozone/snap/refrigerants/qa.html#middle
- ❑ The Global Monitoring Division of the National Oceanic and Atmospheric Administration (NOAA) provides extensive information on ozone depletion and refrigerants: http://www.esrl.noaa.gov/gmd/
- ❑ This excellent Princeton University website provides information on ozone depletion and extensive information of CFC alternatives: http://www.princeton.edu/~chm333/2002/spring/Ozone/
- ❑ The Alternative Fluorocarbons Environmental Acceptability Study provides information on CFC and HCFC alternatives: http://www.afeas.org/atmospheric_chlorine.html
- ❑ In addition to the resources listed above, the EPA maintains information concerning fire extinguisher alternatives at: http://www.epa.gov/ozone/snap/fire/index.html
- ❑ The U. S. Green Building Council *LEED for Schools First Edition* updated November 2007 can be accessed at http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1586
- ❑ Information on curriculum from the Connecticut State Department of Education can be accessed at http://www.sde.ct.gov/sde/cwp/view.asp?a=26188Q=320954&sdenav_gid=1757
- ❑ The following sites have a variety of curriculum and energy education resources available:
    - National Energy Education Development Project (NEED) http://www.need.org/curriculum.php
    - Alliance to Save Energy http://www.ase.org/section/_audience/educators
    - National Energy Foundation http://www.nef1.org/educators.html
    - Energy Information Agency http://www.eia.doe.gov/kids/onlineresources.html

Regulation Compliance Alternative for Building Standard Options

Section 16a-35k-7 Alternative Option

Section 16a-38k-7:Alternative Options to section 16a-38k-4 or section 16a-36k-6	Section 16a-38k-7 Alternative strategies to Section 16a-38k-4 of the Regulations of Connecticut State Agencies or Section 16a-38k-6 of the Regulations of Connecticut State Agencies. (a) As an alternate to meeting the criteria in section 16a-38k-4 of the Regulations of Connecticut State Agencies, a project as defined by sections 16a-38k-2(a) and 16a-38k-2(b) of the Regulations of Connecticut State Agencies-may meet the requirements under section 16a-38k-4 of the Regulations of Connecticut State Agencies by receiving a Leadership in Energy and Environmental Design (LEED) Silver level certification from the United States Green Building Council, or by receiving a Two-Globe rating from the Green Globe system self certification program, providing that the project includes all mandatory requirements within sections 16a-38k-3 and 16a-38k-8 of the Regulations of Connecticut State Agencies. (b) As an alternate to meeting the criteria in section 16a-38k-6 of the Regulations of Connecticut State Agencies, a project as defined by sections 16a-38k-2(c) and 16a-38k-2(d) of the Regulations of Connecticut State Agencies by receiving a Leadership in Energy and Environmental Design (LEED) Silver level certification from the United States Green Building Council, or by meeting the criteria set forth in the Northeast Collaborative for High Performance School Protocol, also known as NE-CHPS, providing that the project includes all mandatory requirements within sections 16a-38k-3, 16a-38k-5, and 16a-38k-8 of the Regulations of Connecticut State Agencies.

Purpose

This alternative compliance approach recognizes the effort required to obtain LEED or Green Globes rating and seeks to avoid duplication of those efforts.

Compliance Assistance for Alternative Option

This alternative approach is available for both new construction and major renovation projects.

In order to utilize this compliance alternative for State Facilities, all of the “mandatory” requirements section 16a-38k-3(a) through (l) must be met. LEED Silver or Green Globes Two-Globe rating may be used only to replace the 26 Building Standard Options required for compliance.

In order to utilize this compliance alternative for schools, all of the "mandatory" requirements of sections 16a-38k-3(a) through (l) and 16a-38k-5(a) through (f) must be met. LEED Silver or Green Globes Two-Globe rating may be used only to replace the 28 Building Standard Options required for compliance.

LEED rating – The U. S. Green Building Council maintains the LEED program which includes a rating system for new and existing commercial buildings. Obtaining a Silver, Gold, or Platinum Certification under the LEED program may be used to demonstrate compliance. LEED "Registration" for the project does not satisfy this requirement, as the project must be officially "Certified" under the LEED program.

Green Globes system – The Green Globes Environmental Assessment and Rating System was adapted from the Canadian Go Green Plus program and is operated by the Green Buildings Initiative. The Green Globes system is a self-certification program that is questionnaire driven, but includes third-party verification. A construction documents questionnaire is the basis for the rating system and covers issues similar to those covered by the LEED rating system. Third party verification follows the self-certification process and is arranged by the Green Buildings Initiative.

Northeast Collaborative for High Performance School Protocol (NE-CHPS) is a is a set of building and design standards that was developed specifically for schools. It is based on California's pioneering Collaborative for High Performance Schools guide, but has been tailored specifically for state code requirements, the New England climate, and the environmental priorities of the region.

Resources

- For information on the LEED rating system, visit the U.S. Green Building Council website: http://www.usgbc.org/
- For information on the Green Globes program, visit the Green Buildings Initiative website: http://www.thegbi.org/home.asp
- For information on the Northeast Collaborative for High Performance Schools, visit the Northeast Energy Efficiency Partnership website: http://www.neep.org/HPSE/ne_chps.html

Compliance Checklist-State Facilities

In order to demonstrate compliance, the reporting requirements detailed in Section 16a-38k-8 must be completed. The following checklist may be used to catalog compliance progress.

Mandatory Requirements

X	Section	Summary Description
	16a-38k-3(a)	Building Commissioning
	16a-38k-3(b)	Integrated Design Process
	16a-38k-3(c)	Base Energy Performance 21% Better Than Code
	16a-38k-3(d)	ENERGY STAR Products
	16a-38k-3(e)	Indoor Air Quality Management Plan
	16a-38k-3(f)	Water Efficiency
	16a-38k-3(g)	Recycling of Materials
	16a-38k-3(h)	Erosion and Sedimentation Control
	16a-38k-3(i)	No Smoking Policy
	16a-38k-3(j)	Integrated Pest Management Plan
	16a-38k-3(k)	CFC Refrigerant Ban or Phase-out Plan
	16a-38k-3(l)	Minimum Ventilation

Building Standard Options

(A minimum of 26 of the following strategies must be implemented.)

X	Section	Summary Description
		At least one measure in subsection (a) must be selected
	16a-38k-4(a)(1)	Energy Performance 24.5% Better Than Code
	16a-38k-4(a)(2)	Energy Performance 28% Better Than Code
	16a-38k-4(a)(3)	Energy Performance 31.5% Better Than Code
	16a-38k-4(a)(4)	Energy Performance 35% Better Than Code
	16a-38k-4(a)(5)	Energy Performance 38.5% Better Than Code
	16a-38k-4(a)(6)	Energy Performance 42% Better Than Code
	16a-38k-4(a)(7)	On-Site Renewable Energy – 3%
	16a-38k-4(a)(8)	On-Site Renewable Energy – 7%
	16a-38k-4(a)(9)	On-Site Renewable Energy – 10%
	16a-38k-4(a)(10)	Purchase Renewable Energy
	16a-38k-4(a)(11)	Energy Measurement and Verification Plan
		At least two measures in subsection (b) must be selected
	16a-38k-4(b)(1)	Install Permanent Indoor Air Monitoring Systems
	16a-38k-4(b)(2)	Provide Increased Outdoor Ventilation
	16a-38k-4(b)(3)	Building Flushout
	16a-38k-4(b)(4)	Low VOC Adhesives and Sealants
	16a-38k-4(b)(5)	Low VOC Paints and Coatings
	16a-38k-4(b)(6)	Low VOC Carpet and Carpet Cushion
	16a-38k-4(b)(7)	Composite Wood and Agrifiber Products

X	Section	Summary Description
	16a-38k-4(b)(8)	Building Design to Control Entry of Pollutants
	16a-38k-4(b)(9)	Individual Lighting Control
	16a-38k-4(b)(10)	Individual Thermal Comfort Control
	16a-38k-4(b)(11)	Building Occupant Survey
	16a-38k-4(b)(12)	Daylight Contribution
	16a-38k-4(b)(13)	Visual Gazing – Views to the Outdoor Environment
	16a-38k-4(b)(14)	Isolation of Chemical Use Areas
		At least one measure in subsection (c) must be selected
	16a-38k-4(c)(1)	Reduce Total Potable Water Usage by 30%
	16a-38k-4(c)(2)	Reduce Water Consumption for Landscaping 50%
	16a-38k-4(c)(3)	Eliminate Potable Water Usage for Landscaping
	16a-38k-4(c)(4)	Reduce Total Potable Water Usage by 50%
		At least two measures in subsection (d) must be selected
	16a-38k-4(d)(1)	Maintain 75% of an Existing Building Structure
	16a-38k-4(d)(2)	Maintain 95% of an Existing Building Structure
	16a-38k-4(d)(3)	Re-use Existing Non-Structural Building Elements
	16a-38k-4(d)(4)	Recycle or Salvage 50% of Construction and Demolition Debris
	16a-38k-4(d)(5)	Recycle or Salvage 75% of Construction and Demolition Debris
	16a-38k-4(d)(6)	Use 5% Refurbished, Salvaged, or Reused materials
	16a-38k-4(d)(7)	Use 10% Refurbished, Salvaged, or Reused materials
	16a-38k-4(d)(8)	Use 10% Recycled Content Materials
	16a-38k-4(d)(9)	Use 20% Recycled Content Materials
	16a-38k-4(d)(10)	Use 10% Local Materials
	16a-38k-4(d)(11)	Use 20% Local Materials
	16a-38k-4(d)(12)	Use Building Materials Made from Short Harvest Cycle Plants
	16a-38k-4(d)(13)	Use Forest Stewardship Council (FSC) Certified Wood Products
		At least two measures in subsection (e) must be selected
	16a-38k-4(e)(1)	Re-develop a Local Site
	16a-38k-4(e)(2)	Develop a Brownfield Site
	16a-38k-4(e)(3)	Select a Site with Public Transportation Access
	16a-38k-4(e)(4)	Encourage Bicycle Transportation
	16a-38k-4(e)(5)	Encourage Low-Emission Vehicle Use with Preferred Parking
	16a-38k-4(e)(6)	Encourage Car and Van-pooling
	16a-38k-4(e)(7)	Protect Natural Areas at the Construction Site
	16a-38k-4(e)(8)	Maximize Open Space
	16a-38k-4(e)(9)	Implement a Stormwater Management Plan Reducing Run-off by 25%
	16a-38k-4(e)(10)	Implement a Stormwater Management Plan that Treats 90% of Annual Rainfall
	16a-38k-4(e)(11)	Reduce Heat Island Effect Through Landscaping Strategies
	16a-38k-4(e)(12)	Select Roofing Materials to Reduce Heat Island Effect
	16a-38k-4(e)(13)	Reduce Outdoor Light Pollution
	16a-38k-4(e)(14)	Orient Building for Daylighting and Energy Performance
	16a-38k-4(e)(15)	Sustainable Site Development

X	Section	Summary Description
		No minimum requirement for measures in subsection (f)
	16a-38k-4(f)(1)	Eliminate the use of CFCs, HCFCs and Halons
	16a-38k-4(f)(2)	Building Innovation
	16a-38k-4(f)(3)	Metering of Buildings
	Total Building Standard Optional Strategies (26 Needed for Compliance)	

Compliance Checklist-Schools

In order to demonstrate compliance, the reporting requirements detailed in Section 16a-38k-8 must be completed. The following checklist may be used to catalog compliance progress.

Mandatory Requirements

X	Section	Summary Description
	16a-38k-3(a)	Building Commissioning
	16a-38k-3(b)	Integrated Design Process
	16a-38k-3(c)	Base Energy Performance 21% Better Than Code
	16a-38k-3(d)	ENERGY STAR Products
	16a-38k-3(e)	Indoor Air Quality Management Plan
	16a-38k-3(f)	Water Efficiency
	16a-38k-3(g)	Recycling of Materials
	16a-38k-3(h)	Erosion and Sedimentation Control
	16a-38k-3(i)	No Smoking Policy
	16a-38k-3(j)	Integrated Pest Management Plan
	16a-38k-3(k)	CFC Refrigerant Ban or Phase-out Plan
	16a-38k-3(l)	Minimum Ventilation
	16a-38k-5(a)	Acoustical Standards
	16a-38k-5(b)	Properly Locate Outside Air Intakes
	16a-38k-5(c)	Electronic Ignition on Natural Gas Equipment
	16a-38k-5(d)	Use of Low VOC Products
	16a-38k-5(e)	Environmental Site Assessment
	16a-38k-5(f)	HEPA Vacuuming

Building Standard Options

(A minimum of 28 of the following strategies must be implemented.)

X	Section	Summary Description
		At least one measure in subsection (a) must be selected
	16a-38k-6(a)(1)	Energy Performance 24.5% Better Than Code
	16a-38k-6(a)(2)	Energy Performance 28% Better Than Code
	16a-38k-6(a)(3)	Energy Performance 31.5% Better Than Code
	16a-38k-6(a)(4)	Energy Performance 35% Better Than Code
	16a-38k-6(a)(5)	Energy Performance 38.5% Better Than Code
	16a-38k-6(a)(6)	Energy Performance 42% Better Than Code
	16a-38k-6(a)(7)	On-Site Renewable Energy – 3%
	16a-38k-6(a)(8)	On-Site Renewable Energy – 7%
	16a-38k-6(a)(9)	On-Site Renewable Energy – 10%
	16a-38k-6(a)(10)	Purchase Renewable Energy
	16a-38k-6(a)(11)	Energy Measurement and Verification Plan
		At least two measures in subsection (b) must be selected
	16a-38k-6(b)(1)	Install Permanent Indoor Air Monitoring Systems

X	Section	Summary Description
	16a-38k-6(b)(2)	Provide Increased Outdoor Ventilation
	16a-38k-6(b)(3)	Building Flushout
	16a-38k-6(b)(4)	Composite Wood and Agrifiber Products
	16a-38k-6(b)(5)	Individual Lighting Control
	16a-38k-6(b)(6)	Individual Thermal Comfort Control
	16a-38k-6(b)(7)	Building Occupant Survey
	16a-38k-6(b)(8)	Daylight Contribution
	16a-38k-6(b)(9)	Visual Gazing – Views to the Outdoor Environment
	16a-38k-6(b)(10)	Mold Prevention
	16a-38k-6(b)(11)	Low VOC Furniture
	16a-38k-6(b)(12)	Isolation of Chemical Use Areas
	16a-38k-6(b)(13)	Control of Particulates at Pedestrian Entryways
		At least one measure in subsection (c) must be selected
	16a-38k-6(c)(1)	Reduce Total Potable Water Usage by 30%
	16a-38k-6(c)(2)	Reduce Water Consumption for Landscaping 50%
	16a-38k-6(c)(3)	Eliminate Potable Water Usage for Landscaping
	16a-38k-6(c)(4)	Reduce Total Potable Water Usage by 50%
		At least two measures in subsection (d) must be selected
	16a-38k-6(d)(1)	Maintain 75% of an Existing Building Structure
	16a-38k-6(d)(2)	Maintain 95% of an Existing Building Structure
	16a-38k-6(d)(3)	Re-use Existing Non-Structural Building Elements
	16a-38k-6(d)(4)	Recycle or Salvage 50% of Construction and Demolition Debris
	16a-38k-6(d)(5)	Recycle or Salvage 75% of Construction and Demolition Debris
	16a-38k-6(d)(6)	Use 5% Refurbished, Salvaged, or Reused materials
	16a-38k-6(d)(7)	Use 10% Refurbished, Salvaged, or Reused materials
	16a-38k-6(d)(8)	Use 10% Recycled Content Materials
	16a-38k-6(d)(9)	Use 20% Recycled Content Materials
	16a-38k-6(d)(10)	Use 10% Local Materials
	16a-38k-6(d)(11)	Use 20% Local Materials
	16a-38k-6(d)(12)	Use Building Materials Made from Short Harvest Cycle Plants
	16a-38k-6(d)(13)	Use Forest Stewardship Council (FSC) Certified Wood Products
		At least two measures in subsection (e) must be selected
	16a-38k-6(e)(1)	Re-develop a Local Site
	16a-38k-6(e)(2)	Select a Site with Public Transportation Access
	16a-38k-6(e)(3)	Encourage Bicycle Transportation
	16a-38k-6(e)(4)	Encourage Low-Emission Vehicle Use with Preferred Parking
	16a-38k-6(e)(5)	Encourage Car and Van-pooling
	16a-38k-6(e)(6)	Protect Natural Areas at the Construction Site
	16a-38k-6(e)(7)	Maximize Open Space
	16a-38k-6(e)(8)	Implement a Stormwater Management Plan Reducing Run-off by 25%
	16a-38k-6(e)(9)	Implement a Stormwater Management Plan that Treats 90% of Annual Rainfall
	16a-38k-6(e)(10)	Reduce Heat Island Effect Through Landscaping Strategies

X	Section	Summary Description
	16a-38k-6(e)(11)	Select Roofing Materials to Reduce Heat Island Effect
	16a-38k-6(e)(12)	Reduce Outdoor Light Pollution
	16a-38k-6(e)(13)	Orient Building for Daylighting and Energy Performance
	16a-38k-6(e)(14)	No Building in Floodplain and Sustainable Site Development
	16a-38k-6(e)(15)	Site Building away from External Sources of Excessive Noise
		No minimum requirement for measures in subsection (f)
	16a-38k-6(f)(1)	Eliminate the use of CFCs, HCFCs and Halons
	16a-38k-6(f)(2)	Building Innovation
	16a-38k-6(f)(3)	Curriculum on Sustainable Building Features
	Total Building Standard Optional Strategies (27 Needed for Compliance)	

High Performance Buildings Glossary

The following are terms that may be encountered in this document and/or in the process of designing and constructing high performance buildings.

ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

ASTM – American Society for Testing and Materials.

biodiesel – A domestic, renewable fuel for diesel engines derived from natural oils like soybean oil, which meets the specifications of American Society for Testing and Materials D 6751. Biodiesel is not the same thing as raw vegetable oil. It is produced by a chemical process that removes the glycerin from the oil.

biogas – Gas, rich in methane, which is produced by the fermentation of animal dung, human sewage, or crop residues in an air-tight container. It is used as a fuel to heat stoves and lamps, run small machines, and generate electricity. The residues of biogas production can be used as a low-grade organic fertilizer.

bio-oil – A liquid created from biomass (see below) found in forestry and agricultural residues. The biomass is thermochemically converted to bio-oil by using processes called direct liquefaction or fast pyrolysis. The high water and oxygen content of bio-oils reduces their heating value to less than half the value of petroleum. However, bio-oils are low in viscosity and have been successfully burned in boilers, kilns, turbines, and diesel engines.

biomass – Any biological material that can be used as fuel. Biomass fuel is burned or converted in systems that produce heat, electricity, or both. In this document, biomass-fired systems refer to systems that are fueled by clean wood chips from forestry or saw mill operations.

brownfields – Industrial or commercial property that is abandoned or underused, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

CSI – Construction Specifications Institute.

COMcheck –Software developed by the U.S. DOE to help commercial projects demonstrate compliance with all commercial energy code requirements for envelope, lighting, and mechanical systems.

commissioning – A systematic process of ensuring that all building systems perform interactively according to the contract documents, the design intent, and the building's operational needs. Commissioning involves three phases: pre-design, construction, and warranty.

commissioning plan – A plan that includes a list of all equipment to be commissioned, delineation of roles for each of the primary commissioning participants, and details on the scope, timeline, and deliverables throughout the commissioning process.

cool roof – A roof that reflects most of the sun's energy instead of absorbing it into the interior spaces below.

daylighting –The practice of placing windows and reflective surfaces so that the natural light of day provides effective internal illumination. Optimize the daylighting design to minimize glare

and eliminate direct-beam light in the classroom and use daylighting controls designed to dim or turn off electric lights when sufficient daylight is available.

Design-Build – A construction-project delivery process in which a single entity assumes the obligation of furnishing the design, supervision, and construction services required to complete a project.

DOE-2 – Software that was developed by the U.S. DOE to predict the fuel consumption (both electric and fossil fuel) of a building based on its design. Later iterations include DOE 2.2, a more advanced form of the original software.

DOE-2.1E – An updated version of DOE-2 software.

eQUEST – (**QU**ick **E**nergy **S**imulation **T**ool) – Sophisticated software that allows for detailed energy analysis of a designed building. It also allows users to build 2-D and 3-D displays of the building geometry.

ENERGY STAR – A program that maintains a database of compliant manufactures and products. Partial list of products include computers, monitors, copy machines, water coolers, printers, scanners, refrigerators, and washing machines.

gray water system – Water that has been used in showers, sinks, and laundry machines that may be reused for other purposes, especially landscape irrigation. Toilet water is not used in this system.

Greenfields – Parcels of land not previously developed beyond that of agriculture or forestry use. The opposite of brownfield.

heat island – An effect caused when exterior surfaces absorb the sun's energy and heat the air near the ground. On a building site, rising temperatures make the air conditioning work harder, increasing energy cost.

HEPA filters – High Efficiency Particulate Air filters

integrated pest management (IPM) – A sustainable approach to managing pests that minimizes economic, health, and environmental risks.

integrated design – The consideration and design of all building systems and components. It brings together the various disciplines involved in designing a building and reviews their recommendations as a whole. It also recognizes that each discipline's recommendation has an impact on other aspects of the building project.

life cycle costing – A means of calculating and comparing different designs, equipment, and products to identity the best investment.

operations and maintenance manual – Provides detailed operations and maintenance information for all equipment and products used in the building.

operations and maintenance training – Provides a short introduction on operations and maintenance of equipment and products for all building staff and then features hands-on workshops for facility personnel.

recycled content – Materials that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer) or after consumer use (post consumer).