SUSTAINABILITY RATING SYSTEMS

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ABSTRACT

There are five different publications that establish guidelines for sustainable building development that are examined in this report: (1) Leadership in Energy and Environmental Design ("LEED"); (2) CalGreen; (3) the International Green Construction Code ("IGCC"); (4) ASHRAE Standard 189.1 ("Standard 189.1"); and (5) The San Francisco's Green Building Ordinance ("SFGBO").

Having multiple publications can cause confusion among building developers, architects, engineers, building consultants, or various jurisdictions on what publication to follow, use, or reference in building development projects.

This article will provide various parties involved in building development a thorough understanding of each publication and the similarities or differences between them, which will ultimately assist in identifying areas for all publications to improve.

Specifically, this article demonstrates that the Material and Energy sections for all the publications must advance beyond the current requirements. Also, the comparison validates that CalGreen's Tier 2 is similar to LEED's local ordinances, like the SFGBO. This may mean two things: (1) LEED will need to advance its gold or platinum certification requirements, or potentially become less relevant; or (2) local ordinances should reference or adopt CalGreen Tier 2 so that there is common language between local and state regulations. This article identifies that LEED has the most stringent guidelines under the Building Site section out of all the publications. Likewise, the IGCC and Standard 189.1 have provisions under the Water Use section, that goes beyond other publications. Additionally, similar language between LEED and Standard 189.1 was found, which was unsurprising as both publications are authored by the USGBC.

KEYWORDS

sustainable building development, local ordinances, jurisdictions, local and state regulations, voluntary & involuntary green building rating systems, LEED, CalGreen, IGCC, ASHRAE 189.1 and SFGBO

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INTRODUCTION

There is an increasing number of guidelines for green building development ("publications") that have been fashioned without much post-publication comparisons of the commonalities between each or consideration of common visions for sustainability. Often, the numerous publication options can cause confusion among building developers, architects, engineers, building consultants, or various jurisdictions on what publication to follow, use, or reference in building development projects. The purpose of this paper is to provide all parties involved in building development a more thorough understanding of each publication and the similarities or differences between them, which will assist in identifying areas for all publications to progress.

There are five key publications that are analyzed in this paper: (1) Leadership in Energy and Environmental Design ("LEED"); (2) CalGreen; (3) The International Green Construction Code ("IGCC"); (4) ASHRAE Standard 189.1 ("Standard 189.1"); and (5) San Francisco's Green Building Ordinance ("SFGBO"). These five publications are a mix between voluntary and involuntary guidelines for green building development. Green buildings "offer one way to mitigate the current and growing environmental impacts from the built environment."[3]

LEED is a voluntary rating system created and maintained by the U.S. Green Building Council ("USGBC") that evaluates a building's environmental design and offers multiple levels of certification (Certified, Silver, Gold, or Platinum).[4] LEED's 2009 rating system for New Construction and Major Renovations is used for the purposes of this analysis.[5] LEED is "largely based on an assessment of the design intentions of the design team and attempts to ensure that much of this is translated into the built form."[6]

While some jurisdictions across the United States have adopted LEED certification as a standard for any new construction, California has adopted the first ever-statewide green building code, or involuntary rating system, CalGreen.[7] CalGreen is a building code, and chapter 11 of California Code of Regulations Title 24. CalGreen went into effect January 1, 2011 and is the nation's first mandatory statewide green building code.

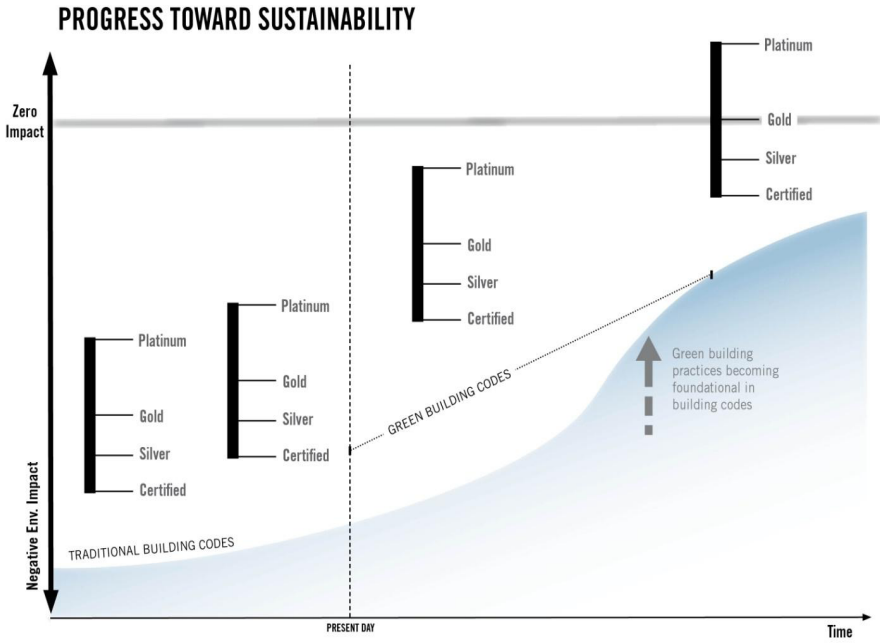
The comparison between LEED and CalGreen is an important one, because since LEED was created in 1998 there have been over 5,000 LEED certified buildings constructed in California. It is still too early to determine if or how CalGreen will impact the rate at which LEED certification is awarded, but the greater the similarities between the two publications may mean that LEED will need to adapt beyond the standards listed in CalGreen or lose relevancy.

The figure below demonstrates how this concern has been recognized by the USGBC, which governs LEED, and recognizes that as building codes advance to address sustainable building construction and operation, LEED certification will need to respond by advancing its requirements for certification.

The IGCC is a standard put in place by the International Code Council[9] in association with cooperating sponsors American Society for Testing and Materials International (ASTM) and the American Institute of Architects (AIA) as an alternative tool to voluntary rating system with mandatory language intended to be adopted by and administered by jurisdictions. The IGCC targets the market segment that is not likely react to voluntary programs. The IGCC has a section dedicated to project electives, which allows the parties involved in the building process to advance the project beyond the IGCC's minimum requirements.

Standard 189.1, Standard for High-Performance Green Buildings Except Low-Rise Residential Buildings, is an American National Standards Institute (ANSI) standard developed by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

FIGURE 1. LEED Certification vs. Green Building Codes.[8]



in association with the Illuminating Engineering Society (IES) and the USGBC for the design of high-performance green buildings.[10] The IGCC accepts Standard 189.1 in lieu of following the standards prescribed by the IGCC.

The SFGBO is an ordinance that imposes green building requirements on newly constructed residential and commercial buildings, and renovations to existing buildings in San Francisco, California.[11] The SFGBO often references LEED and in specific sections requires a higher threshold above that set by LEED.

The raw analysis of each publication is completed by first breaking each publication into common sections then comparing each section to determine where gaps and similarities currently exist in each publication. Whether each publication uses the same measures or metrics to determine a specific guideline for each section is also discussed.

COMPARISON

Within the five (5) publications: (1) LEED; (2) Standard 189.1; (3) IGCC; (4) CalGreen; and (5) the SFGBO there are six (6) sections that this paper compares. The sections were selected because each publication considers the topic. The sections are: (1) Sites; (2) Energy; (3) Water; (4) Materials; (5) Internal Air Quality ("IAQ") / Environmental Air Quality; and (6) Commissioning. Under each section there may or may not be various subsections. The subsections were selected because each publication either considers or should consider the topic.

Sites

Standard 189.1 contains similar requirements as LEED in the Sustainable Sites Section, excluding requirements around bicycles and priority parking. Standard 189.1 utilizes the same metric for measuring light pollution as LEED.

The IGCC is unique in that it has a great deal of requirements regarding soil testing for subsurface greywater irrigation systems. It also has an extensive section aimed at protecting a building site's natural resources, specifically soil and vegetation. Additionally, it forbids the use of potable water for irrigation. Lastly, when compared to LEED, the IGCC holds less stringent requirements regarding how close one can build to wetlands by twofold.

CalGreen's section on Planning and Design contains few requirements including stormwater during and post construction, light pollution, priority parking and bicycle parking. CalGreen requires both long-term and short-term bike parking for 5% of the motorized vehicle parking capacity, yet does not require changing rooms like LEED and the IGCC.

The SFGBO has two requirements for sites, which both relate to stormwater: (1) stormwater management and design must follow guidelines of the San Francisco Public Utilities Commission;[12] and (2) guidelines for stormwater quantity and quality that to meet or exceed LEED SS6.1 and SS6.2 guidelines.

Energy

Under the Energy section, there are ten (10) subsections within our comparison: (1) Energy Performance[13]; (2) Energy Prescriptive[14]; (3) Renewable Energy; (4) Energy Efficient Appliances; (5) Elevators, Escalators, etc.; (6) Thermal Bridging; (7) Metering; (8) Green Power; (9) Moisture Control; and (10) Demand Response.

(1) Energy Performance

Currently, LEED sets the standard for Energy Performance and is based off ASHRAE version 90.1-2007, which is the Energy Standard for Buildings except Low-Rise Residential Buildings,[15] and goes up to a 48% energy cost savings. The new draft of LEED, which has not been released yet, has a few changes regarding how Energy Performance is calculated. Currently, Option 1 in LEED is Whole Building Energy Simulation and uses Energy Cost, but the new version of LEED "calls for a combination of energy cost and source Energy Use Intensity ("EUI")." EUI "is a unit of measurement that describes a building's energy use and it represents the energy consumed by a building relative to its size. A building's EUI is calculated by taking the total energy consumed in one year (measured in kBtu) and dividing it by the total floorspace of the building."[16] The new version of LEED also references ASHRAE 90.1-2010 instead of ASHRAE 90.1-2007, the former of which is more stringent. The Optimize Energy Performance credit, under the expected new version of LEED, also has some changes with a more stringent baseline for receiving points and provisions for project teams "to establish an energy performance target during the schematic design phase, and for the simulation option, use the energy modeling process to inform their design."[17] Standard 189.1 has numerous requirements that supersede ASHRAE 90.1-2007, which LEED references for Energy Performance. On average, Standard 189.1 is 27% more energy efficient than ASHRAE 90.1-2007, and also moves to incorporate CO_2 and demand reduction measures into the Energy Performance of a building.

The IGCC has numerous requirements for Energy Performance documentation and Energy Performance verification. The measurement-based compliance under the IGCC is to be performed by an approved agency that documents the energy use of the building. Minimum performances are based on Total Annual Net Energy Use ("TANEU"), building peak energy demand, and reduced CO_2e emission calculations and reporting. Buildings are to

comply with the 2006 International Energy Conservation Code to have a TANEU score of 100. As previously mentioned, LEED is based off the ASHRAE 90.1-2007 for Energy Performance, which is the Energy Standard for Buildings Except Low-Rise Residential Buildings[18] and ranges up to a 48% energy cost savings.

CalGreen references energy code Title 24, Part 6, of the California Code of Regulations for Energy Performance provisions. Under CalGreen, to achieve the optional Tier 1 and Tier 2 improvements Energy Performance improvement must go beyond Title 24, Part 6 by 15% or 30%. This is in terms of energy, not energy cost or CO_2e and exclusive of plug loads. As a result of plug load exclusion, an actual apple to apples comparison is likely with Tier 1 at 10% and Tier 2 at 20%.

The SFGBO provisions are for documentation by a Commissioning Agent that demonstrate fundamental commissioning of the building energy systems. This is LEED EA Prerequisite 1 and is referenced by the SFGBO.

(2) Energy Prescriptive

Standard 189.1 has the same provisions for Energy Prescriptive as Energy Performance. The IGCC provides prescriptive-based compliance for the Energy Prescriptive section and shall be deemed to have a TANEU score of 70. LEED's Energy Prescriptive section also references ASHRAE 90.1 while CalGreen references energy code Title 24, Part 6.[19]

(3) Renewable Energy

Standard 189.1 has specific provisions for Renewable Energy requiring on-site renewable energy systems to provide an annual energy production of no less than 6.0 kBtu/ft.^{2} Exclusions exist under Standard 189.1 for projects that do not receive more than 4.0 kw/m^{2}day and for projects that purchase Green-e Energy[20] of at least 7 kWh/ft^2 of conditioned space each year until the cumulative purchase is equal to 70 kWh/ft^2 of conditioned space. LEED provides points for a range of 1–13% of generated energy via on-site Renewable Energy sources. Possible points available under LEED for Renewable Energy range from one (1) point to seven (7) points and these Renewable Energy potential includes solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies.

The IGCC has provisions for building performance-based compliance and building prescriptive compliance for Renewable Energy system requirements. The provisions for Renewable Energy are for system performance monitors and metering. There are also provisions under the IGCC for solar photovoltaic systems, wind energy systems, and solar water heating equipment.

CalGreen does not have any mandatory requirements for Renewable Energy, however, per section A5.211.1, CalGreen suggests that the use of on-site renewable energy for at least one percent (1%) of the electrical service overcurrent protection device rating should be calculated in accordance with the 2007 California Electrical Code or 1KW, whichever is greater. In addition to the electrical demand required to meet one percent (1%) the natural gas and propane use is to be calculated in accordance with the 2007 California Plumbing Code. In section A5.211.4, CalGreen also references prewiring for future solar by requesting the installation of conduit from the building roof of eave to a location within the building identified as suitable for future installation of a charge controller and inverter.

The SFGBO provision is for solar electric systems under Renewable Energy. In this section there are installation provisions, compliance with third party verification, methodology of calculating the energy equivalent, and photovoltaic credit provisions.

(4) Energy Efficient Appliance

Standard 189.1 has prescriptive minimum equipment efficiency requirements under Energy Efficient Appliances. Specifically, Standard 189.1 has provisions for products to have a baseline efficiency addressed in the National Appliance Energy Conservation Act ("NAECA"), Energy Policy Act ("EPAct"), and the Energy Independence and Security Act ("EISA"). Standard 189.1 also has provisions for appliances to comply with the greater of the Energy Star requirements references in section 7.4.7.3. LEED does not directly address Energy Efficient Appliances in this section.

Provisions for efficiency of permanent and portable appliances exist under the IGCC for the Energy Efficiency Appliances section. Similar to Standard 189.1, the IGCC references Energy Star. The requirement under the IGCC are that the building owner or in tenant-occupied buildings, each tenant, is to maintain (on site) a list of the installed portable Energy Star eligible appliances and equipment. The IGCC also requires the aggregate rated power of all the Energy Star qualified portable appliances and equipment to be at least 50% of aggregate rated power of all portable appliances and equipment.

Under CalGreen there are no mandatory provisions required in Energy Efficient Appliances, but all equipment and appliances provided by the builder shall be Energy Star labeled if Energy Star is applicable to that equipment or appliance.

There are no provisions for this section under the SFGBO.

(5) Elevators, Escalators

Both Standard 189.1 and LEED do not directly address the energy requirements for Elevator, Escalator, Etc. The IGCC has provisions for power conversion systems for traction elevators, motors with Class IE2 efficiency rating, or alternative technologies that have equal or better efficiency. Provisions for elevator transmission efficiency and drive provisions for potential energy released during motion are to be recovered under IGCC. The IGCC also has specific requirements for escalators and their energy recovers, requiring down-running escalators with direct variable frequency drives to use regenerative drives and return recovered energy to the power grid. Standby mode provisions for buildings with multiple elevators serving the same floors are that one or more elevators is to be switched to sleep or low power mode during periods of low traffic. Similar standby mode provisions exist for escalators or moving walkways.

CalGreen, like Standard 189.1 and LEED, also has no mandatory provisions under this section but buildings with more than one elevator or two escalators should have controls provided to reduce the energy demand of elevators and reduce the speed of escalators under. CalGreen also requests documentation of the controls in the project specifications and commissioning plan. There are no provisions for this section under the SFGBO.

(6) Thermal Bridging

None of the publications directly address Thermal Bridging though LEED and Standard 189.1 note that potential and precedent exist for applicability through exceptional calculation. CalGreen also has no mandatory provisions but the design for steel framing be done to avoid thermal bridging.

(7) Metering

LEED has a provision to develop a Measurement and Verification Plan consistent with the International Performance Measurement & Verification Protocol ("IPMVP") for implementation in the post occupancy phase. Standard 189.1, on the other hand, does not reference

the IPMVP, however, it does provide detailed guidance by source energy and sub-system thresholds.

The IGCC has a provision to determine energy use and peak demand. The IGCC permits utility energy meters to be used to collect whole building data. There are provisions under the IGCC for metering gaseous fuels, liquid fuels, solid fuels, electric power, district heating and cooling, combined heat and power, renewable and waste energy, and energy load type sub-metering. Along with those specific provisions there are also Measurement and Verification provisions for meters, sub-meters, and other approved devices.

There are no mandatory provisions in CalGreen for Metering, but there is a Energy Monitoring section that requests sub-metering or equivalent combinations of sensor measurements and thermodynamic calculations, if appropriate, to record energy use data for each major energy system in the building.

There are no provisions for this section under the SFGBO.

(8) Green Power

Standard 189.1 references the prescriptive Renewable Energy systems requirement exclusion for projects that purchase Green-e Energy[21] of at least 7 kWh/ft2 of conditioned space each year, until the cumulative purchase is equal to 70 kWh/ft^2 of conditioned space. LEED also references the purchase of Green-e certified Renewable Energy certificates for 35% of total energy demand.

There is nothing explicitly stated about Green Power under the IGCC, however, measures exist on calculating annual energy use and electric power. Provisions also exist in the IGCC on solar electric power, wind power systems, and other renewable energy electric production systems.

CalGreen does not have any mandatory provisions for Green Power, but it has two voluntary tiers (Tier 1 and Tier 2) that require participation in the local utility's renewable energy portfolio program that provides a minimum of 50% of the electrical power from renewable sources. CalGreen also requests the utility bills are saved to maintain documentation. There are no provisions for this section under the SFGBO.

(9) Moisture Control

Standard 189.1 and LEED do not directly address Moisture Control with the exception of moisture control during construction and adequate air ventilation rates. The IGCC also addresses Moisture Control during the construction phase. The IGCC also has provisions for a Moisture Control plan and Moisture Control during the construction phase. Unlike LEED and Standard 189.1, the IGCC has additional project elective provisions for inspections and compliance for foundation sub-soil drainage systems, foundation damp proofing and waterproofing, exterior wall coverings, and roof coverings. Unlike LEED and Standard 189.1, the IGCC does not directly address adequate air ventilation rates.

CalGreen references California Building and Energy Code requirements under this section. CalGreen also has a section termed "Water Resistance and Moisture Management," which requires the project to provide a weather-resistant exterior wall and foundation envelope as required by California Building Code Section 1403.2 (Weather Protection) and California Energy Code Section 150, (Mandatory Features and Devices), manufacturer's installation instructions or local ordinance, whichever is more stringent. There are no provisions for this section under the SFGBO.

(10) Demand Response

Under Demand Response, Standard 189.1 requires peak demand be reduced by 10% or more by containing automatic systems, like demand limiting or load shifting. Standard 189.1 does not allow standby power generation to be used to achieve the peak demand reduction. Demand Response is not directly referenced in LEED, but it will be a new credit under the new version of LEED providing two options to reduce the peak demand for utility power. The first option is to "participate in a demand-response program through a local utility."[22] The second option is to "implement electrical load-shifting measures, such as ice storage, that permanently transfer regulated electricity demand from daytime hours to off-peak hours."[23]

The IGCC has detailed provisions for an open and interoperable Automated Demand Response ("Auto-DR") infrastructure. Provisions in the IGCC exist for Demand Response Automation Server ("DRAS"), heating, ventilating, and air-conditioning ("HVAC") systems, rebound avoidance (to prevent rebound peak), lighting, and building component-specific strategies.

CalGreen does not have mandatory provisions for Demand Response, but options to have the HVAC systems include Direct Digital Control Systems and centralized lighting systems with preprogrammed demand response strategies that are automated with either a Demand Response Automation Internet Software Client or dry contact relays. CalGreen also has optional measures for the capacity to shed load by cooling temperature set point adjustment and total lighting loads by a minimum of 30% through dimming control or bi-level switching.

There are no provisions for this section under the SFGBO.

Water

Unlike LEED, Standard 189.1 does not specify a certain amount of potable water reduction. LEED requires a reduction in potable water consumption of at least 50%, however, Standard 189.1 does outline design requirements that lead to a reduction in potable water use. Standard 189.1 also specifies the need for smart controllers for irrigation systems and plumbing fixtures such as valve type flow volumes and rates that are acceptable. LEED has similar provisions but does not require the use of certain strategies to attain them. Standard 189.1 has more stringent requirements for the use of potable water in mechanical systems and equipment and requires water-efficient mechanical equipment. LEED does not address the water consumption of mechanical systems.

The IGCC has three options for the reduction of potable water irrigation that are comparable to LEED, though one IGCC option that denies the use of potable water for irrigation purposes, is more stringent. The IGCC has provisions for a 30%-40% reduction of potable water use in plumbing fixtures, while LEED has a slightly higher requirement of at least a 50% reduction. Though LEED does not have any provisions addressing the water consumption of mechanical systems, the IGCC is comparable to Standard 189.1 where it limits or prohibits the use of potable water in certain mechanical systems and equipment and requires water-efficient mechanical equipment.

CalGreen contains similar provisions to Standard 189.1 that require smart controllers for irrigation systems. Though CalGreen does not have specifications for a reduction in potable water consumption for irrigation, like LEED does, CalGreen does require a water budget conforming to the California Department of Water Resources Model Water Efficient Landscape Ordinance,[24] if no local ordinance is applicable. CalGreen has provisions for the plumbing fixtures and fittings to be used, as well as the reduction of potable water and wastewater in plumbing fixtures by 20%. LEED has provision for a reduction of at least 50% reduction of

both potable water and wastewater. Similarly to LEED, CalGreen does not have any provisions that address the water consumption of mechanical systems.

SFGBO references LEED for provisions on irrigation and plumbing fixtures. They both require at least 50% reduction in potable water use for landscaping. While SFGBO requires a minimum of 30% reduction of potable water for plumbing fixtures, LEED specifies a 50% reduction. Like LEED (and CalGreen), the SFGBO does not have provisions addressing the water consumption of mechanical systems.

LEED Water Efficiency Notes and Expected Changes

The new version of LEED, which is expected to be released mid-2011, has a few revisions to the Water Efficiency section and several new provisions. The revisions to the Water Efficiency section include that the Water Efficient Landscaping section is renamed to Landscape Water Use Reduction and is a prerequisite applying to all projects with over 1,000ft^2 of exterior vegetated space. Under this section's provisions, established by the WaterSense Water Budget Tool, exist to reduce water use by 30%.[25] Another change to LEED is that the Innovative Wastewater Technologies credit under Water Efficiency is renamed to Sustainable Wastewater Management. This section provides three different "options" to fulfill the requirement. The first option, which is "to reduce water use for sewage conveyance by 50%, is simply reworded" in the new version of LEED.[26] The second option changes from focusing on the treatment of wastewater onsite to focusing on reusing the wastewater. The third option is new, requiring "resource recovery and reuse from 25% of the baseline nitrogen or organic carbon loading from building occupants".[27]

New provisions under LEED include a new prerequisite for Appliance and Process Water Use Reduction, which sets performance requirements for appliances and processes (like heat rejection and cooling). Additional Appliance and Process Water Use Reduction allows projects to accumulate points for water efficiency and builds off the new prerequisite. Cooling Tower Makeup Water is a new credit that provides measures to "conserve water used for cooling tower makeup while controlling microbes, corrosion, and scale in the condenser water system".[28]

Materials

Under the Materials section there are twelve (12) subsections within the comparison: (1) Recyclable Collection; (2) Construction Waste; (3) Reused Materials; (4) Recycled Content; (5) Regional Materials; (6) Renewable Materials; (7) Recyclable Materials; (8) Certified Wood; (9) Life-Cycle Assessment; (10) Policy; (11) Service Life; (12) Architectural Efficiency.

(1) Recyclable Collection

LEED and Standard 189.1 both allocate areas that are dedicated to the storage of materials for recycling. Standard 189.1 has a specific section, 9.3.4.3, requiring proper storage and disposal measures for fluorescent, HID lamps, and ballasts. The storage and collection section under LEED is a pre-requisite, yet provides credit opportunities for maintaining the existing building structure, and building envelope. LEED also provides credit if at least 50% (by area) of the completed building used existing (pre-construction) interior nonstructural elements.

Similarly to LEED and Standard 189.1, the IGCC also has area dedicated to the storage of materials for recycling. IGCC requires space to be provided in buildings for the storage of discarded lamps, batteries, electronics and other items that require special disposal practices in the jurisdiction.

Like LEED, Standard 189.1, and the IGCC, CalGreen also has provisions for allocated areas that are dedicated to the storage of materials for recycling, under this section. CalGreen references specific sections on how space allocation for recycling areas are to be dealt with and are to comply with Chapter 18, Part 3, Division 30 of the Public Resources Code. The storage and collection section under LEED is a pre-requisite, yet provides credit opportunities for maintaining the existing building structure, and building envelope.

The SFGBO has provisions for providing an area for Recyclable Collection and storage of materials for recycling.

(2) Construction Waste

LEED has recently made the construction and demolition waste management plan into a pre-requisite under the new version of LEED, set to be released to the public mid-2011, with no minimum threshold for implementation.[29] Under Standard 189.1, a minimum of 50% of nonhazardous construction and demolition waste material are to be diverted from disposal in landfills and incinerators by recycling/reuse. Also, new building projects on sites with less than 5% existing buildings, structures or hardscape, total amount of construction waste generated on project are not to exceed 42 yd^3 of the new building floor area. Standard 189.1 also provides information on extracting, harvesting, and/or manufacturing stating that all must be done in accordance to the laws and regulation of the country of origin.

The IGCC requires that at least 35 percent of construction phase waste materials be diverted from landfills, and allows the jurisdiction to increase the materials required to be diverted and to increase material diversion from landfill by 20%.

CalGreen allows either a construction waste management plan for the diverted materials or meet local construction and demolition waste management ordinance, whichever is more stringent. Recycling of construction waste is now directed in some municipalities in the U.S.[30] Under CalGreen, specific guidelines are outlines where a local jurisdiction does not have a construction and demolition waste management ordinance, submit a construction waste management plan for approval by the enforcement authority that:

1. Identifies the materials to be diverted from disposal by efficient usage, recycling, reuse on the project, or salvage for future use or sale.
2. Determines if materials will be sorted on-site or mixed.
3. Identifies diversion facilities where material collected will be taken.
4. Specifies that the amount of materials diverted shall be calculated by weight or volume, but not by both.

CalGreen also provides specific information on the required documentation process; projects located in areas beyond the haul boundaries of the diversion facility, and excavated soil and land clearing debris.

SFGBO requires LEED points to be increased by 10% if a building was demolished and was a historical resource. SFGBO also references LEED for this section with a provision for the diversion of at least 75% of the project's construction debris.

(3) Reused Materials

LEED provides an opportunity to receive points under Reused Materials if the project uses salvaged, refurbished or reused materials, the sum of which constitutes at least 5% or 10%, based on cost, of the total value of materials on the project. Standard 189.1 does not have

any provisions for this section. The IGCC at least 55% of the total materials in each building project must be reused materials and a whole building life cycle assessment is to be provided.

CalGreen has no specific requirements for this section.

The SFGBO references LEED, requiring one additional credit to be achieved under LEED MR3 (Reused Materials), MR4 (Recycled Content), MR5 (Regional Materials), MR6 (Renewable Materials), or MR7 (Certified Wood) through January 1, 2011. Effective January 1, 2012 two additional credits are to be achieved in accord with the above LEED section. The re-use or restoration of certain "character defining" features of historical features will be granted additional points or credits.

(4) Recycled Content

LEED provides three options to use materials with Recycled Content, which is the fourth subsection under this Materials section. The three LEED options are: (1) such that the sum of postconsumer; (2) recycled content plus 1/2 of the preconsumer: (3) content constitutes at least 10% or 20%, based on cost, of the total value of the materials in the project. Standard 189.1's requirement looks similar to the third option above by requiring the sum of post-consumer recycled content plus one-half of the pre-consumer recycled content to constitute a minimum of 10% based on cost of the total materials in building project. The IGCC states recycled content materials must contain at least 25 percent combined post-consumer and pre-consumer recovered material, and must be recyclable.

CalGreen has no information on this section, but has voluntary provisions requiring the use of either pre-consumer or post-consumer material to contain 10% or 15% recycled content of the total material cost, which are voluntary tiers. See subsection (3) Reused Materials, above for SFGBO requirements.

(5) Regional Materials

LEED, Standard 189.1, and the IGCC have provisions to use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site. The benefit of local material use is that there is the possibility of reducing carbon emissions associated with transportation.[31] The difference between them is that LEED requires a range between a minimum of 10% or 20%, based on cost, of the total materials value, while Standard 189.1 requires a minimum of 15% of building materials or products used, based on cost, to be regionally extracted/harvested/recovered. The IGCC has special provisions for materials transported by water or rail, which is unique to this section.

CalGreen has no mandatory provisions in this section, though the voluntary provisions are similar to LEED, having 10% of the total materials value to be within 500 miles of the project site. See subsection (3) Reused Materials, above for SFGBO requirements.

(6) Renewable Materials

Renewable Materials is the next subsection. LEED uses rapidly renewable building materials and products for 2.5% of the total value of all building materials and products used in the project, based on cost. Standard 189.1 requires a minimum of 5% of building materials used, based on cost, to be biobased products. The IGCC does not measure renewable materials the same as LEED, instead the IGCC requires the bio-based materials have at least 50% bio-based content and recyclable materials have a minimum recovery rate of 30%. CalGreen has no mandatory provisions but the voluntary provisions are the same as LEED. See subsection (3) Reused Materials, above for SFGBO requirements.

(7) Recyclable Materials

LEED, Standard 189.1, CalGreen, and the SFGBO do not have any specific requirements for Recyclable Materials section. The IGCC requires that recyclable materials be with a minimum recovery rate of 30%.

(8) Certified Wood

The Certified Wood subsection is next. LEED requires a minimum of 50% (based on cost) use of wood-based materials and products that are certified in accordance with the Forest Stewardship Council's principles and criteria, for wood building components. This includes, at a minimum, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes. Standard 189.1 require wood building component to not contain less than 60% certified wood content tracked through a chain of custody process. The IGCC does not have any specific requirements for Certified Wood

CalGreen also does not have any special requirements for Certified Wood, but voluntary measure indicated that the California Building Standards Commission ("CBSC") would continue to develop a standard through the next code cycle.

See section (3) above for SFGBO requirements.

(9) Life-Cycle Assessment

Under the Life-Cycle Assessment ("LCA") section, unlike Standard 189.1, LEED does not have a section covering the life-cycle assessment for materials. Standard 189.1 has three sections covered under life-cycle assessment: (1) life-cycle assessment performance—where a project is to have 5% improvement over the other building alternative assessed in the LCA in a minimum of two impact categories; (2) procedure—the life-cycle assessment is to include the following 3 steps (a) perform lifecycle inventory (LCI), (b) compare two building alternatives, and (c) conduct a critical review by an external expert independent of those performing the LCA; and (3) reporting—the following to be submitted to AHJ: (a) LCA report (b) documentation of critical peer review by third party.

IGCC requests a whole building LCA under the Materials, Reused Materials section. The SFGBO does not address LCA.

(10) Policy

There are no provisions for Policy under LEED, Standard 189.1, CalGreen or the SFGBO.

The IGCC requires that at least 75 percent of the total materials in each project must comply with requirements for the following items: (1) for the country in which the project is located; (2) for the country in which the materials; or (3) products are harvested, extracted, processed and manufactured, whichever are more restrictive. IGCC also has policy for the following four sections:

a. Clean air: United States of America air Pollution Control Act (1955); Clean Air Act (1963); Air Quality Act (1967); Clean Air Act (1972); Clean Air Act Extension (1977); and Clean Air Act (1990).
b. Clean water: United States of America Federal Water Pollution Control Act (1948); Water Quality Act (1967); Federal water Pollution Control Act (1972); Clean Water Act Amendments (1977); and Clean Water Act Reauthorization (1987).
c. Resource conservation: United States of America Resource Conservation and Recovery act (RCRA) (1976) and RCRA Amendments (1984).
d. Noise control: United States of America Noise Control Act (1972).

(11) Service Life

There are no provisions for Service Life under LEED, Standard 189.1, CalGreen or the SFGBO. The IGCC requires that a Building Service Life Plan be included in the construction documents for the project and provides detailed requirements for the plan. The IGCC also requires an increase in building service life to 200 years or 100 years.

(12) Architectural Efficiency

There are no provisions for Architectural Efficiency under LEED, Standard 189.1, CalGreen or the SFGBO.

The IGCC has a section for multi story footprint which requires the floor area, excluding stairways and shafts, reduces footprint by a) 45% or b) 70%. The IGCC also has a section for building volume that requires a reduction in residential floor-to-floor & floor-ceiling average to 11 feet, others to 12.5 feet.

Internal Air Quality ("IAQ") / Environmental Air Quality

In this next section, there are twenty (20) subsections: (1) Outdoor Air; (2) Tobacco Smoke; (3) Outdoor Air Monitoring; (4) During Construction; (5) Before Occupation; (6) Adhesives / Sealants; (7) Paints / Coatings; (8) Flooring / Carpet; (9) Composite Wood; (10) Pollutant Isolation; (11) Controllability; (12) Thermal Comfort; (13) Daylight; (14) Views; (15) Acoustics; (16) Radon; (17) Fireplace; (18) Air Filtration; (19) Ozone / GHG; and (20) Moisture Control.

(1) Outdoor Air

Standard 189.1 and LEED both have Outdoor Air requirements per ASHRAE 62.1, which is the Ventilation for Acceptable Indoor Air Quality established by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). However, to achieve the credit under LEED either the mechanical ventilation needs to be increased by 30% or the naturally ventilated spaces need to show they meet the Chartered Institution of Building Services Engineers ("CIBSE") requirements.

IGCC has provisions for the building ventilation during construction and building flush out provisions after construction.

CalGreen has provisions for mechanically or naturally ventilated spaces in buildings to follow requirements of Section 121 of the California Energy Commission ("CEC"), California Code of Regulations ("CCR"), Title 24, Part 6 or the applicable local code, whichever is more stringent. CalGreen also requires Chapter 4 of the CCR, Title 8, to be met. CO_2 monitoring is required for demand control ventilation.

(2) Tobacco Smoke

For Tobacco Smoke Standard 189.1 and LEED are similar in that they both prohibit smoking 25 feet from the envelope openings of the building unless there are designated smoking areas. Signage is required in both Standard 189.1 and LEED, but Standard 189.1 specifies that signage needs to be posted within 10 feet of entryways. Under Standard 189.1 smoking is not allowed in any building.

The IGCC's provisions are less stringent; stating that the design of building spaces and HVAC systems for jurisdictions that permit tobacco smoking by the occupants within buildings or tenant spaces is allowed.

CalGreen also has a no smoking provision within 25 feet from the building envelope, or to follow local regulation, whichever is more stringent. Under CalGreen when ordinances,

regulations, or policies are not in place, signage should be posted to inform building occupants of the prohibitions of Tobacco Smoke.

(3) Outdoor Air Monitoring

Standard 189.1 and LEED have similar provisions for Outdoor Air Monitoring, except under Standard 189.1 the monitoring system needs to be capable of measuring flow within a accuracy of +/- 15% of the minimum outdoor air flow rate. LEED is more stringent because the provisions for a permanently installed Outdoor Air Monitoring system that generates an alarm if outdoor air or CO_2 levels exceed a 10% deviation from design values.

The IGCC and CalGreen do not explicitly state the requirements for Outdoor Air Monitoring or the accuracy of measurement devices.

(4) During Construction

Both Standard 189.1 and LEED require an IAQ Management Plan in the During Construction section. LEED has provisions for the IAQ Management Plan to be for the construction and pre-occupancy phases of the project while Standard 189.1 includes moisture protection of absorptive materials, and restricted idling of construction vehicles. LEED has provisions to meet or exceed the Sheet Metal and Air Conditioning Contractors' National Association ("SMACNA") control measures, protect stored absorptive materials from moisture damage, and if permanently installed air handlers are used during construction that a filter of a least Minimum Efficiency Reporting Value ("MERV") 8 need to be installed and then replaced prior to occupancy. [32]

The IGCC has provisions for building ventilation during construction. LEED has provisions for the IAQ Management Plan to be for the construction and pre-occupancy phases of the project.

CalGreen has mandatory provisions for covering duct openings and protecting mechanical equipment During Construction. The voluntary measures CalGreen has are similar to LEED in stringency.

(5) Before Occupation

Under the Before Occupation section both LEED and Standard 189.1 are effectively equivalent and require a building flush-out or IAQ testing.

Like LEED and Standard 189.1, the IGCC also has provisions to flush-out the building after construction though LEED and Standard 189.1 are more stringent than IGCC in the requirements.

There are no mandatory provisions under this section for CalGreen, but voluntary measures include a plan to flush-out the building after construction.

(6) Adhesives / Sealants

For the Adhesives/Sealants section LEED requires that all adhesives and sealants used in the interior of the building must comply, as applicable to the project scope, with South Coast Air Quality Management District ("SCAQMD") for adhesives, sealants, and sealant primers. Standard 189.1 has provisions that all adhesives and sealants used on the interior of the building need to comply with the emissions requirements of California Section 01350[33], and Volatile Organic Compounds ("VOC") contents should comply with SCAQMD Rule 1168[34] or Green Seal Standard GS-36.[35]

The IGCC has provisions that a minimum of 85% by weight or volume, of applied Adhesives and Sealants, to comply with VOC content in accordance with the appropriate standard being either the U.S. EPA Method 24, SCAQMD Method 304, 316A, or 316B.

CalGreen requirements are that all adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers and caulks are to comply with local, or regional, air pollution control, or air quality management district rules, or with SCAQMD Rule 1168[36] Volatile Organic Compounds ("VOC") limits.

Like LEED, the SFGBO has provisions that all Adhesives/Sealants used in the interior of the building must comply, as applicable to the project scope, with SCAQMD for adhesives, sealants, and sealant primers.

(7) Paints / Coatings

LEED, Standard 189.1, and the IGCC have provisions that limit the VOC content of Paints and Coatings. The IGCC has alternative emissions testing that is to be performed by a laboratory that has the CA/DHS/EHLB/R-174 test methodology in the scope of its ISO 17025 Accreditation.

Similarly to LEED, CalGreen and the SFGBO limit the VOC content of Paints and Coatings. CalGreen explicitly states the need to verify compliance through documentation.

(8) Flooring / Carpet

Standard 189.1 and LEED both have provisions covering Flooring and Carpet. Provisions under Standard 189.1 are that carpet and hard surface flooring in office spaces need to comply with California Section 01350. Provisions under LEED are for carpet to be tested and compliant to various standards. Under LEED all hard surface flooring needs to be compliant with FloorScore standards.[37] The SFGBO references LEED in this section requiring the same provisions.

The IGCC has provisions for a minimum of 85% of the total area of flooring installed within the interior of the building to comply with listed product and for flooring with more than one distinct product the emissions from each layer to comply with specific requirements. There is also emissions testing required and is to be performed by a laboratory that has the CA/DHS/EHLB/R-174 test methodology in the scope of its ISO 17025 Accreditation.

CalGreen provisions for Flooring and Carpet include that at least 50% of carpet needs to be compliant with the Resilient Floor Covering Institute ("RFCI") FloorScore program.

(9) Composite Wood

LEED had provisions for Composite Wood and agrifiber products used on the interior of the building cannot contain added urea-formaldehyde resins. LEED also requires laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies cannot contain added urea-formaldehyde resins. Standard 189.1 also prohibits urea-formaldehyde resins. Under Standard 189.1, emissions need to comply with a third-party certification submission indicating compliance with California Air Resource Board's ("CARB") regulation and limit requirements for either office or classroom spaces regardless of space type.

The IGCC has provisions for Composite Wood by requiring interior particleboard, hardwood plywood, and medium density fiberboard used as sub-flooring and decorative wall coverings, and permanently installed millwork to be rated for exterior exposure in accordance

with DOC PS1[38] or DOC PS 2,[39] made using adhesives which do not contain urea-formaldehyde resins. The IGCC has provisions for compliance with the requirements of Section 93120 of Title 17, California Code of Regulations, which is Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products.

Under CalGreen, formaldehyde in Composite Wood needs to conform to limits specified by the California Environmental Protection Agency's Air Resources Board ("ARB") Air Toxics Control Measure for Composite Wood. Similarly to LEED, CalGreen also has provisions that the building interiors do not contain added urea-formaldehyde resins.

(10) Pollutant Isolation

Standard 189.1 requires all building entrances to employ an entry mat system that has a scraper surface, absorption surface, and a finish surface. The LEED credit for Pollutant Isolation requirements include an entryway system, similar to Standard 189.1, except LEED requires at least a 10 foot long system which is longer than Standard 189.1's requirement. LEED also requires a sufficiently exhausting of spaces where hazardous gases or chemicals may be present or used is required. In mechanically ventilated buildings LEED requires air filters to be a minimum of MERV 13. Hazardous liquid waste containment is also required under LEED.

The IGCC has provisions for Pollutant Isolation that require enclosed rooms or spaces greater than 200 square feet in area, used as print or copy facility, janitorial room, repair garage or aircraft hangar, where chemical use occurs to have: (1) walls constructed to resist passage of airborne chemical pollutants; (2) doors to be automatic or self-closing; and (3) HVAC systems which provide separate exhaust airflow to outdoors at a rate of not less than 0.50 cfm[40] per SF and maintains negative pressure of not less than 7 pa[41] within the room, and prohibits recirculation of air from room to other portions of the building.

There are no mandatory provisions under the Pollutant Isolation section for CalGreen, but the voluntary measures specify a need for entryway systems, of 6 feet, that minimize and control pollutant entry.

(11) Controllability

For Controllability, Standard 189.1 specifies that thermal comfort needs to be met, but there are no provisions for controllability. The IGCC and LEED credits have provisions for Controllability of lighting and systems for thermal comfort.

No mandatory provisions exist under CalGreen for Controllability, but voluntary measures address the issue of controllability of lighting and systems for thermal comfort.

(12) Thermal Comfort

Standard 189.1 has provisions to design the building in compliance with ASHRAE Standard 55[42] for Thermal Comfort. LEED also has provisions to meet Thermal Comfort criteria established by ASHRAE Standard 55, and, additionally, to verify Thermal Comfort through occupant survey.

The IGCC has vague language asking Thermal Comfort to be met "to the extent that is feasible" following criteria established by ASHRAE Standard 55 and 62.1.[43]

There are no provisions to design a building in order to meet a certain level of Thermal Comfort under CalGreen, but voluntary measures address controllability for the purposes of thermal comfort, as mentioned above.

(13) Daylight

While both Standard 189.1 and LEED have a Performance Option for Daylighting and both are to perform a simulation to show that at least 75% of Daylighting zones achieve daylight illuminance. Standard 189.1 requires the illuminance of at least 30fc (footcandles) at 3 feet above the floor, while LEED requires at least 25fc.

The IGCC contains a Performance and Prescriptive requirement. The Performance provision, under the IGCC, is that all points in the daylight area have daylight saturation of no less than 60%.

CalGreen has no mandatory provisions for Daylighting but voluntary provisions exist that reference the California Energy Code requirements for top lighting and side lighting.

(14) Views

Standard 189.1 does not have provisions for Views. LEED has provisions for line of sight for purposes of maximizing ones view. The IGCC has project elective provisions for line of sight for purposes of maximizing View.

There are no mandatory provisions for Views under CalGreen but the voluntary measures are the same as the LEED and the IGCC, which has provisions for line of sight for purposes of maximizing view.

(15) Acoustics

Standard 189.1 specifies Acoustical ratings of a building envelope and interior wall and floor-ceiling assemblies for different buildings and space types. LEED does not have any provisions for this section.

The IGCC has provisions for Acoustics that require specifications of the acoustical ratings of the building envelope and interior wall and floor-ceiling assemblies.

CalGreen has exterior sound provisions that are similar to Standard 189.1, which specifies acoustical ratings of the building envelope and interior wall and floor-ceiling assemblies for different building and space types. The only difference is CalGreen does not break down acoustical rating requirements by space type for interior sound.

(16) Radon

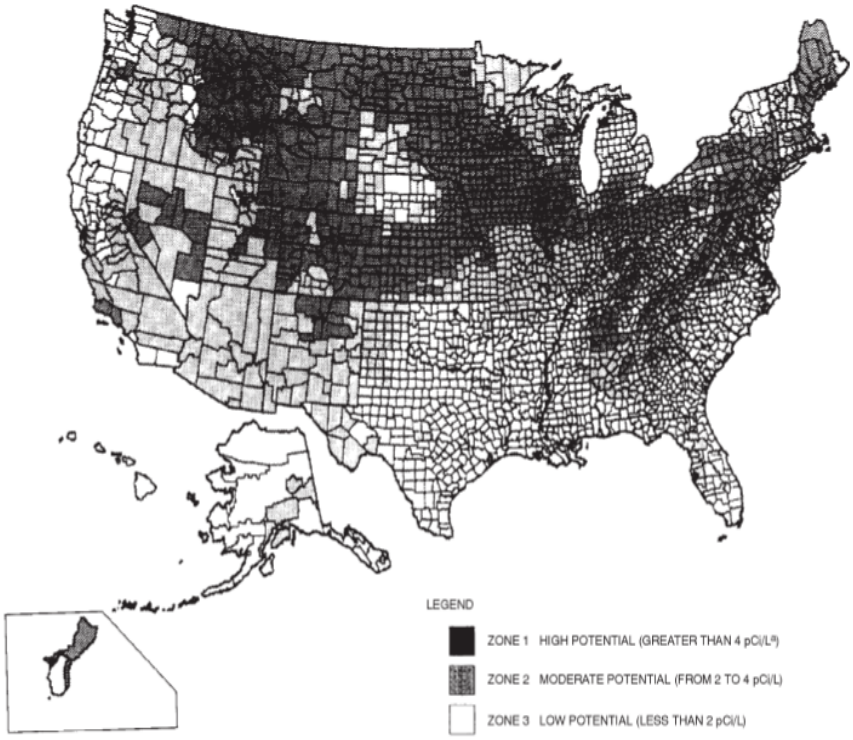
Standard 189.1 has provisions for Radon, specifying building projects that include construction or expansion of a ground-level foundation and which are located on brownfield sites or in "Zone 1" areas identified to have a significant probability of Radon concentrations higher than 4 picocuries/liter on the USEPA map of radon zones, shall have a soil gas retarding system installed between the newly constructed space and the soil. LEED and CalGreen do not have any provisions for this section.

Like Standard 189.1, the IGCC does have provisions for Radon mitigation where building projects are in high Radon Potential locations (Zone 1) and like Standard 189.1 references the USEPA map. See Figure 2 below for the EPA map of Radon Zones.

(17) Fireplace

Standard 189.1 and LEED have no provisions for the Fireplace section. The IGCC has provisions provided for fireplace installation, ventilation, gas fireplaces, and wood-burning fireplaces. CalGreen has provisions that limit the Fireplace type and indicates that the Fireplace must comply with local ordinances.

FIGURE 2. EPA Map of Radon Zones.



(18) Air Filtration

In the Air Filtration section, Standard 189.1 has provisions to provide filters of at least MERV 8. In sites that are designated, as "non-attainment", filters should be provided of at least MERV 13. LEED has provisions, to achieve the pollutant source control credit, for mechanically ventilated buildings to have air filters that have a minimum of MERV 13. The IGCC, like LEED, has provisions for mechanically ventilated buildings to have air filters that have a minimum of a MERV 13 rating. The IGCC also requires filters for ducted space conditioning systems to have a minimum MERV rating of 6. CalGreen, similarly to Standard 189.1, has provisions to provide filters of at least MERV 8. There are voluntary provisions under CalGreen that require a MERV rating of 11.

(19) Ozone / GHG

Under the Ozone / GHG section LEED prohibits the use of chlorofluorocarbons ("CFC") based refrigerants in new building base HVAC&R systems. LEED includes two options for credits in this section: (1) not use refrigerants; or (2) use refrigerants that minimize, or eliminate, the emission of compounds that contribute to ozone depletion and climate change. Standard 189.1, like LEED, prohibits CFC-based refrigerants.

Under the Ozone / GHG section, the IGCC, like Standard 189.1 and LEED, prohibits the use of chlorofluorocarbons ("CFC") based refrigerants in new building. The IGCC also has provisions that prohibit Halons.

CalGreen, like Standard 189.1 and LEED, prohibits CFC-based refrigerants. CalGreen, like the IGCC, also prohibits Halons. The voluntary measures under CalGreen match the LEED provisions in stringency.

(20) Moisture Control

Both Standard 189.1 and LEED do not directly address Moisture Control with the exception of moisture control during construction and adequate air ventilation rates.

The IGCC, like LEED and Standard 189.1, has Moisture Control provisions during the construction phase. The IGCC also has project elective, or voluntary, provisions for moisture preventative measures and inspection procedures for five items: (1) foundation sub-soil drainage systems; (2) foundation damp-proofing and water-proofing; (3) flashing of windows, exterior doors, skylights, wall flashing and drainage systems; (4) exterior wall coverings; and (5) roof coverings, roof drainage, and flashing.

The CalGreen provisions for Moisture Control require that the provisions of California Building Code, CCR, Title 24, Part 2, Sections 1203 (Ventilation) and Chapter 14 (Exterior Walls) must be met. Additional mandatory measures under CalGreen provide moisture control by specifying design of sprinklers and various entries/openings.

Commissioning

LEED's Commissioning requirements include one prerequisite and two credits. Credits include enhanced commissioning, and Measurement and Verification. All of these points are within Energy and Atmosphere. The intention of these credits is to ensure the design is implemented into reality to the energy related specifications of the design. LEED requisite requirements are very basic consisting of: (1) identify commissioning agent; (2) commissioning plan; and (3) commissioning report. Under the Measurement and Verification credit for LEED provisions exist for an energy conservation plan covering at least one-year post occupancy.

Unique to Standard 189.1 is that an acceptance representative leads the review of construction documents before a permit is obtained regarding sensors, devises and control sequences. The acceptance representative also performs testing and verifies the system manual, mechanical systems, lighting, renewable energy, water, and energy management before the building is occupied. The commissioning required under Standard 189.1 is very similar to LEED with requirements including commissioning for heating ventilation, A/C, IAQ, refrigeration systems, controls, thermal and moisture integrity of assemblies, pressurization, lighting controls and shading, irrigation, plumbing, domestic water, service water, renewable energy, water measurement devises, and energy measurement devices. The owner retains the System Manual, the Final Commissioning Report, and measurement and verification documentation under Standard 189.1. Like LEED, Standard 189.1 requires an erosion and sediment plan and requires air conveying devices covered during construction. Additionally, Standard 189.1 requires a high performance building plan of operation that consists of: (1) verifying vegetation is properly maintained when required for shading, tracking and assessing building water consumption and water storage devices for a minimum of three (3) years; (2) the collection and storage of energy data of each device, report, track, and assessment of energy use; and (3) the monitoring of outdoor airflows which consist of recording data on site or installing devices to react when outdoor airflow is 15% lower than the minimum outdoor airflow rate. Standard 189.1 also requires offer of incentives for the use of mass transit, non-motorized transit, carpools, support to reduce commuting of employees by 5%, or initiating rideshare.

IGCC has commissioning requirements similar to LEED, but unique to IGCC are requirements of roof coverings, exterior wall coverings, flashing, and foundation drainage system. Similar to LEED and Standard 189.1, the IGCC requires Measurement and Verification of energy use and energy efficiency. Unique requirements under IGCC include: vegetative roofs and terraces, shading, erosion/sediment control, and soil percolation. The IGCC also has commissioning of imported soils and site/land use.

CalGreen, like Standard 189.1 and LEED, has a CxA to make sure construction meets the owners project requirements. CalGreen has a unique level of detail of what will be in the Commissioning Plan, requiring commissioning goals, systems to be commissioned, an explanation of the design intent, describes testing procedure, schedules, and various responsibilities.

SFGBO has no unique requirements and shares LEED's provisions for Measurement, Verification, and Operation as well as the documentation process and maintenance manual.

GRAPHICAL ANALYSIS

After considering the analysis of the different publications, it is useful to have two graphical analyses of the information discussed above.

The first graph, Figure 3 (attached hereto as Addendum A), is an analysis of the five publications at the minimal requirement to get certification under LEED, or the mandatory requirements under ASHRAE, the IGCC, CalGreen and the SFGBO.

The second graph, Figure 4 (attached hereto as Addendum B), is also an analysis of the publications, but at the "greenest level"; meaning the figure considers each allowable credit available under LEED, the project electives under the IGCC, and Tier 2 of CalGreen. The two graphical analyses are color coded to represent whether each publication discusses each line item under the specific section. The color-coding is ranges across four different shades of yellow to green. If there was little to no content discussed under that topic the cell is shaded in yellow. If, however, the publication showed leadership in the requirements in that topic it is shaded dark green. The two light green shades ranging between yellow and dark green represent a "good" and "very good" requisite within the topics.

Figure 5 (attached hereto as Addendum C), is a textual comparison of five different publications as shown in Figure 3 and 4. Like Figure 3 and 4, Figure 5 is color-coded to demonstrate various levels of stringency, however, when a cell has no shading that means that shading there is no to minimal content under that topic.

The coding scheme in Figure 3 provides a snapshot of how stringent the five publications are in terms of green building development:

- Building Sites and Indoor Environmental Quality: LEED shows the greatest leadership.
- Water, Energy, and Materials: the IGCC shows the greatest leadership.
- Energy: the IGCC leads in the Energy section in both Figures 3 and 4.
- Building Site, Materials, or Indoor Environmental Quality: CalGreen's mandatory requirements are weaker than LEED's minimal certification; however, as shown in Figure 4, Tier 2 of CalGreen shows comparable levels of leadership, or stringency, to LEED. Under the Materials section, the IGCC, however, is the only publication that discusses policy and building service life at any substantive depth.
- Commissioning: Standard 189.1 shows the greatest leadership

Figures 3 and 4 also show where gaps exist in each publication, even at the publication's most stringent level. For example, under the Energy and Materials sections, none of the publications show leadership in thermal bridging, recycled content, regional materials, renewable materials, or architectural efficiency.

The figures also demonstrate that the SFGBO does not have unique requirements, nor does it contain language that raises the thresholds of any specific section.

CONCLUSION

The five publications analyzed in this article have been drafted without much post-publication comparison between each other. Now, after comparing the commonalities and differences between five publications, it is clear that there are important areas for each publication to improve.

The comparison between the various publications demonstrates that the Materials sections for all of the publications needs to advance, including the guidelines for life-cycle assessment measures, policy measures which are to be accounted for, and specific architectural efficiency measures development parties involved should take into consideration.

The comparison also demonstrates that there are areas under the Energy section that have room for improvement, in terms of environmental stringency. Specifically, under the section on Thermal Bridging, none of the publications directly address this topic.

More specifically, because CalGreen Tier 2 is so similar to LEED, local ordinances, like the SFGBO, should reference or adopt CalGreen Tier 2 so that there is common language between local and state regulations. Additionally, CalGreen Tier 2's provisions are very similar to LEED's. This may mean that LEED will need to advance its gold or platinum certification requirements, or potentially become less relevant. In general, however, CalGreen's mandatory requirements are narrower than LEED, Standard 189.1, and the IGCC.

Also, the SFGBO, which mainly references building developments to meet or exceed LEED guidelines, needs to adopt Tier 2 CalGreen provisions. The SFGBO mentions local regulatory departments on specific sections, like the San Francisco Public Utilities Commission for guidelines regarding stormwater management and design. If SFGBO adopts Tier 2 CalGreen provisions, to be completed for new projects or major renovations, there will be greater consistency of language within the state. This will not only allow San Francisco to continue to show leadership on a local level, but also allow for improved synergy throughout what the state regulatory system requires.

Like LEED, Standard 189.1 was authored by the USGBC, which unsurprisingly results in similarities in the language between the two. LEED has the most stringent guidelines under the Building Site out of all the publications while Standard 189.1 and the IGCC have provisions under Water Use that expand beyond the other publications.

These are all areas for the publications to progress. Whether or not each publication makes changes, it is now clear where gaps exist, which will assist the parties involved in building development.

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NOTES

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32. MERV ratings are a way to judge the effectiveness of a filter. MERV was developed by ASHRAE and has values varying from 1 to 16. The higher the MERV value is, the more efficient the filter will be in trapping airborne particles.
33. Section 01350 consists of procedures to ensure good indoor air quality to protect human health established by the California Department of Public Health ("CDPH").
34. SCAQMD Rule 1168: *Adhesives and Sealant Applications*, (Amended January 7, 2005), http://www.aqmd.gov/rules/reg/reg11/r1168.pdf, (March 2011).
35. Green Seal Standard GS-36 is a Green Seal Standard for Commercial Adhesives.
36. SCAQMD Rule 1168: *Adhesives and Sealant Applications*, (Amended January 7, 2005), http://www.aqmd.gov/rules/reg/reg11/r1168.pdf, (March 2011).
37. *Scientific Certification Systems ("SCS") and the Resilient Flooring Covering Institute ("RFCI")* developed FloorScore: Indoor Air Quality. FloorScore "tests and certifies hard surface flooring and flooring adhesive products for compliance with rigorous indoor air quality emissions requirements." http://www.scscertified.com/gbc/floorscore.php, (March 2011).
38. PS 1 is the U.S. Department of Commerce (DOC) Voluntary Product Standard for Construction and Industrial Plywood provides specifications on how plywood needs to be manufactured.
39. PS 2 is the U.S. Department of Commerce (DOC) Voluntary Performance Standard for Wood-Based Structural Use Panels provides specifications on how a panel product must perform in a designated application, rather than how it must be manufactured.
40. cfm = cubic foot per minute
41. pa = pascal pressure unit
42. ASHRAE Standard 55-2004: Thermal Environmental Conditions for Human Occupancy
43. ASHRAE Standard 62.1 is the Ventilation for Acceptable Indoor Air Quality established by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).

ADDENDUM A

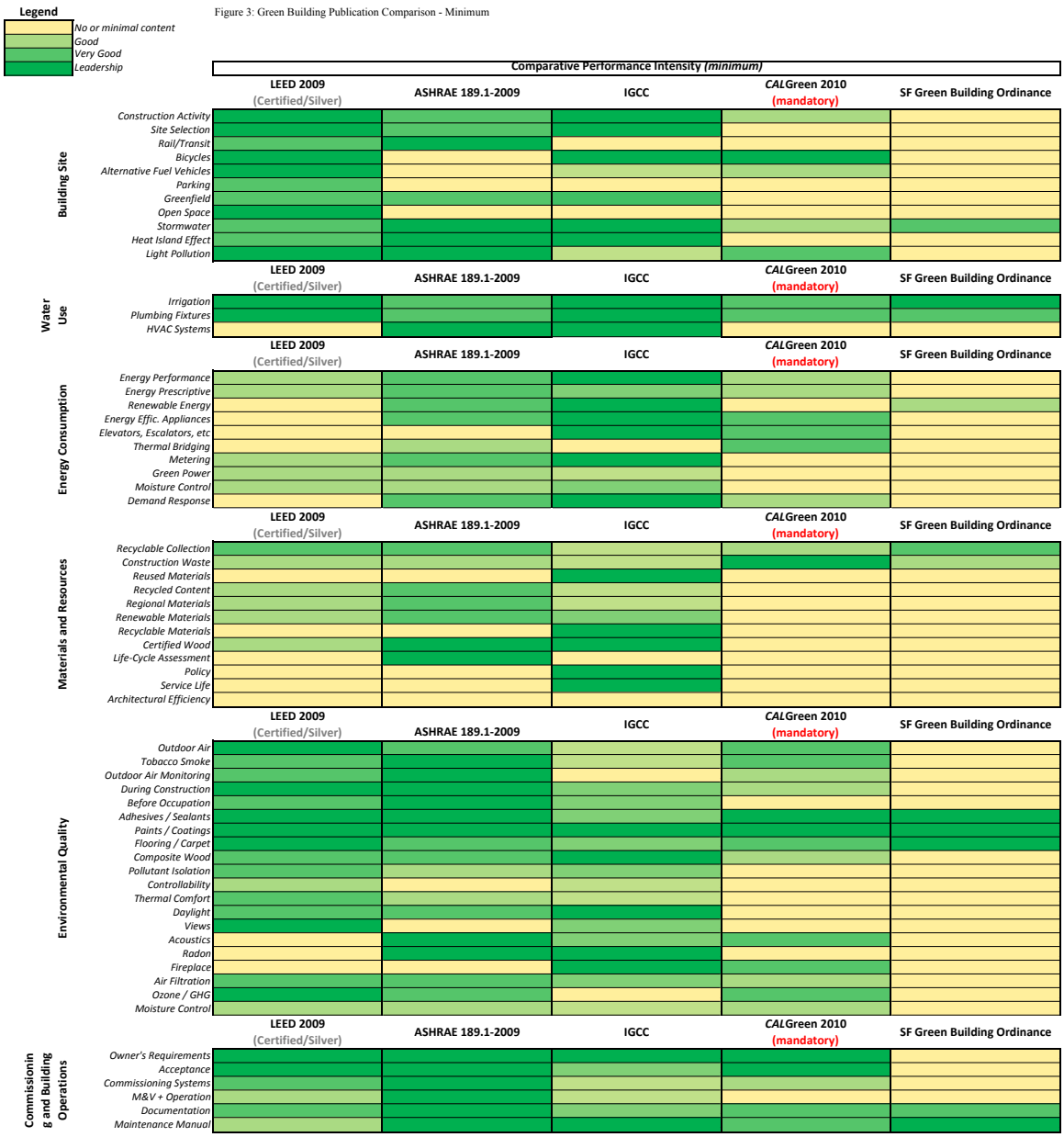
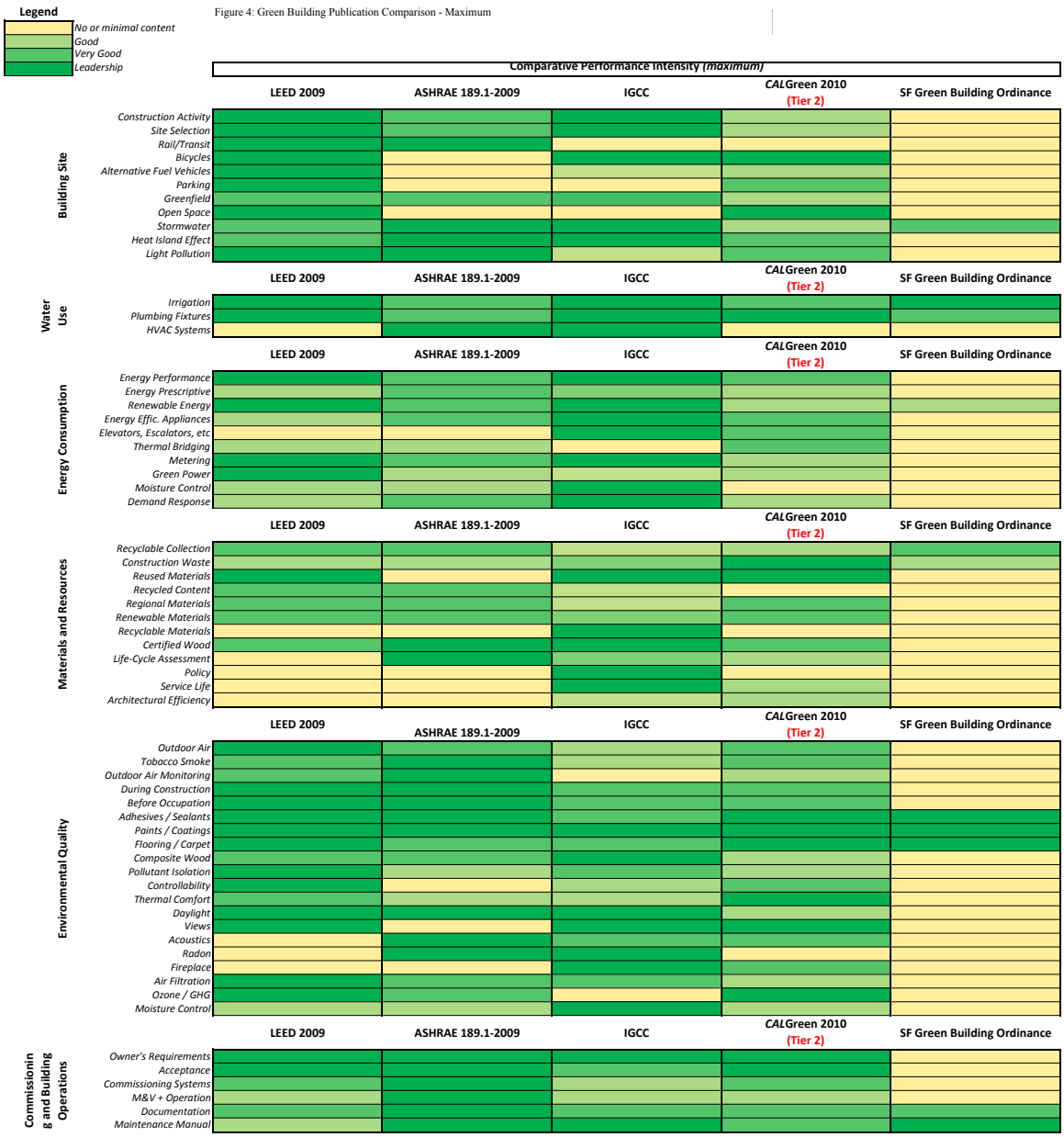


Figure 3: Green Building Publication Comparison - Minimum

ADDENDUM B



ADDENDUM C

Figure 5: Contextual Green Building Publication Comparison

		LEED 2009	ASHRAE 189.1-2009	IGCC-PV1	*CAL*Green 2010	SF Green Building Ordinance
Building Site	*Construction Activity Site Selection*	Has provisions to reduce water and air pollution and erosion Prohibits building on certain sites	Has provisions to reduce water and air pollution and erosion Allows building on certain sites subject to building purpose (e.g. forestry building on forested land)	Has provisions to reduce water and air pollution and erosion Prohibits building on certain sites	Has provisions to reduce water and air pollution and erosion No mandatory provision, but voluntary provisions exist	
	Rail / Transit	Has provisions for proximity to rail and mass transit	Same provisions as Option 1 in LEED 2009	No provisions	No provisions	
	Bicycles	Requires bike parking and showers	No provisions	Requires bike parking and showers	Provisions for bike parking but not showers (showers are voluntary)	
	Alternative Fuel Vehicles	Provides several options addressing alternative fuel vehicles, including, parking, fuel stations, vehicle sharing program	No provisions	Provisions for alternative fuel vehicle parking	Provisions for alternative fuel vehicle parking and stall marking	
	Parking	Provides options to restrict additional parking or offer preferred parking to carpools	No provisions	No provisions	No provisions	
	Greenfield	Limits disturbance certain distances away from project boundaries	Allows siting on greenfield sites located near public transit unless it is agricultural or forest land. Provisions focus on retention of native plants and vegetated area for the prescriptive option.	Disturbance or development shall not be permitted on greenfield sites. Exception: The development of new buildings and associated site improvements shall be permitted on greenfield sites where the jurisdiction determines that adequate infrastructure exists.	No provisions yet	
	Open Space	Provisions to maximize open space	No provisions	No provisions	No mandatory provision, but voluntary provisions exist	
	Stormwater	Provides several options to reduce stormwater but does not have specific requirements in terms of how to meet the provisions	Also provides options to reduce stormwater and has specific criteria that need to be met in order to satisfy the requirements	Provides options to reduce stormwater and specific criteria that need to be met in order to satisfy the requirements. Also requires a stormwater management plan.	Requires a stormwater management plan	Provisions for stormwater management and design to follow the guidelines of the San Francisco Public Utilities Commission. Provisions to meet or exceed LEED SS6.1 and SS6.2 guidelines.
	Heat Island Effect	Provides provisions for reducing heat island effect by requiring at least 50% of hardscape use a combination of reflective hardscape (SRI of 29), shading using vegetation, shading using structures, using an open-grid pavement system (at least 50% pervious). Or parking spaces to have a green roof.	Provisions very similar to that of LEED, with slight variations and more detailed language specifying how to meet the requirements.	Provisions very similar to that of LEED, with slight variations and more detailed language specifying how to meet the requirements.	No mandatory provision, but voluntary provisions exist	
	Light Pollution	Provisions for light pollution reduction by having requirements for exterior lighting as well as interior lighting. Refers to ASHRAE Std 90.1 for exterior power allowances, with errata or addenda	Provisions similar to that of LEED while having more detailed requirements. ASHRAE 189.1 does not have provisions for interior lighting. Refers to ASHRAE Std 90.1 with Addendum	Provisions for lighting pollution reduction by having specific requirements for exterior lighting. No provisions for interior lighting.	Requires compliance with the lighting power requirements in the CEC, CCR, Part 6. Simply indicates that the design of both interior and exterior lighting needs to result in zero direct-beam illumination leaving the building site.	
		LEED 2009	**ASHRAE 189.1-2009**	**IGCC-PV1**	***CAL*Green 2010**	**SF Green Building Ordinance**
Water Use	*Irrigation*	Specifies a certain reduction in potable water consumption for irrigation (at least 50%) and indicates an option to use no potable water	Does not specify a certain amount of potable water reduction but outlines design requirements that lead to a reduction in potable water use. Specifies the need for smart controllers for irrigation systems	Specifies three options 1) reduction in potable irrigation water use by 50%; 2) reduction of building related potable irrigation water use by 50% compared to measured irrigation water use; 3) use no potable irrigation water	Has similar provisions as ASHRAE 189.1, namely the requirement of smart controllers. A water budget conforming to the California Department of Water Resources Model Water Efficient Landscape Ordinance is required if no local ordinance is applicable.	Permit applicants must submit documentation verifying that a minimum 50% reduction in use of potable water for landscaping was achieved. (LEED WE1.1)
	Plumbing Fixtures	Specifies a certain reduction of potable water use (at least 50%) for sewage conveyance, or treatment of at least 50% of wastewater, but does not require the use of certain strategies to attain those provisions.	Does not specify a certain amount of potable water reduction but outlines design requirements that lead to a reduction in potable water use. Specifies criteria such as valve types, flow volumes and rates.	Specifies provisions for reducing potable water and by 30%-40%. Specifies criteria such as valve types, flow volumes and rates.	Provisions for reducing potable water and wastewater by 20%, but also specifies the plumbing fixtures and fittings to be used	Provisions for water reduction and documentation to verify a minimum of 30% reduction in use of potable water was achieved. (LEED WE3.2).
	HVAC Systems	Does not have any provisions that address the water consumption of mechanical systems	Limits or prohibits the use of potable water in certain mechanical systems and equipment and requires water-efficient mechanical equipment	Limits or prohibits the use of potable water in certain mechanical systems and equipment and requires water-efficient mechanical equipment	Does not have any provisions that address the water consumption of mechanical systems	
		LEED 2009	**ASHRAE 189.1-2009**	**IGCC-PV1**	***CAL*Green 2010**	**SF Green Building Ordinance**
Energy Consumption	*Energy Performance*	Sets the standard for performance. Based off 90.1 and ranging up to 48% energy cost savings for full point tally.	Numerous requirements supersede ASHRAE 90.1 2007. ASHRAE Standard 189.1 ~27% more energy efficient than ASHRAE 90.1-2007 (on average). Also moves to incorporate CO2e and demand reduction measures.	Numerous requirements for energy performance documentation and energy performance verification. Measurement-based compliance to be performed by an approved agency that documents the energy use of the building. Provisions for minimum performance based on Total Annual Net Energy Use (TANEU), building peak energy demand, and reduced CO2e emissions calculations and reporting. Buildings complying with 2006 International Energy Conservation Code to have a TANEU of 100.	References energy code Title 24 part 6. Tier 1 and Tier 2 are optional improvements at 15% and 30% respectively beyond Title 24 part 6. NOTE THAT THIS IS IN TERMS OF ENERGY (not energy cost or CO2e) AND EXPULSIVE OF PLUG LOADS. As a result of plug load exclusion, actual applies to apples comparison is likely Tier 1: 10% and Tier 2: 20%.	Provisions for documentation by Commissioning Agent demonstrating fundamental commissioning of the building energy systems. (LEED EA Prereq.1)
	Energy Prescriptive	References ASHRAE 90.1 - 10% improvement.	same as "Energy Performance"	Provisions for prescriptive-based compliance and shall be deemed to have a TANEU of 70.	References energy code Title 24 part 6.	
	Renewable Energy	Generate 1-13% of energy via on-site renewable energy sources.	Building projects shall contain on-site renewable energy systems that provide annual energy production no less than 6.0 Kbtu/ft2. Exclusions for projects that don't receive more than 4.0kw/m2day and for projects that purchase Green-e energy of at least 7 kWh/ft2 of conditioned space each year until the cumulative purchase is equal to 70 kWh/ft2 of conditioned space.	Provisions for building performance-based compliance and building prescriptive compliance for renewable energy systems requirements. Provisions for renewable energy system performance monitors and metering. Provisions for solar photovoltaic systems, wind energy systems, and solar water heating equipment.	No mandatory requirement, however per: A5.211.1 On-site renewable energy. Use on-site renewable energy for at least 1 percent of the electrical service overcurrent protection device rating calculated in accordance with the 2007 California Electrical Code or 1KW, whichever is greater, in addition to the electrical demand required to meet 1 percent of natural gas and propane use calculated in accordance with the 2007 California Plumbing Code. A5.211.4 Prewiring for future solar. Install conduit from the building roof or eave to a location within the building identified as suitable for future installation of a charge controller (regulator) and inverter.	Provisions for solar electric systems; from installation to compliance with third party verification to methodology of calculating the energy equivalent to the photovoltaic credit.
	Energy Effic. Appliances	Not directly addressed, though potential and precedent exists for applicability through exceptional calculation.	Energy Star required in 7.4.3 and 7.4.7 prescriptive requirements by equipment type.	Provisions for efficiency of permanent and portable appliances. Provisions for building owner or, in tenant-occupied building, each tenant, to maintain on site a list of installed portable ENERGY STAR - eligible appliances and equipment. Aggregate rated power of all ENERGY STAR-qualified portable appliances and equipment to be at least 50% of aggregate rated power of all portable appliances and equipment.	No mandatory requirement, however per: A5.204.1 ENERGY STAR equipment and appliances. All equipment and appliances provided by the builder shall be ENERGY STAR labeled if ENERGY STAR is applicable to that equipment or appliance.	
	Elevators, Escalators, etc.	Not directly addressed, though potential and precedent exists for applicability through exceptional calculation.	Not directly addressed, though potential and precedent exists for applicability through exceptional calculation.	Provisions for power conversion systems for traction elevators; motors with Class IE2 efficiency rating or alternative technologies, that have equal or better efficiency. Provisions for elevator transmission efficiency. Drive provisions for potential energy released during motion to be recovered. Provisions for escalators and energy recovery; down-running escalators with direct variable frequency drives to use regenerative drives and return recovered energy to the power grid. Standby mode provisions for buildings with multiple elevators serving the same floors, one or more elevators to be switched to sleep, low power, mode during periods of low traffic. Provisions for escalators or moving walkways in standby mode also exist.	No mandatory provision, however per A5.212.1 Elevators and escalators. In buildings with more than one elevator or two escalators, provide controls to reduce the energy demand of elevators and reduce the speed of escalators. Document the controls in the project specifications and commissioning plan.	
	Thermal Bridging	Not directly addressed, though potential and precedent exists for applicability through exceptional calculation.	Not directly addressed, though potential and precedent exists for applicability through exceptional calculation.	No Provisions.	No mandatory provision, however per A5.213.1 Steel framing. Design for and employ techniques to avoid thermal bridging.	
	Metering	Develop a Measurement and Verification Plan consistent with the IPMVP for implementation in post occupancy phase.	Detailed guidance provided by source energy and sub-system thresholds. Does not reference IPMVP.	Energy type metering provisions to determine energy use and peak demand. Utility energy meters permitted to be used to collect whole building data. Provisions for metering gaseous fuels, liquid fuels, solid fuels, electric power, district heating and cooling, combined heat and power, renewable and waste energy, and energy load type sub-metering. Measurement and verification provisions for meters, sub-meters, and other approved devices.	No mandatory provision, however per A5.204.2 Energy monitoring. Provide sub metering or equivalent combinations of sensor measurements and thermodynamic calculations, if appropriate, to record energy use data for each major energy system in the building.	
	Green Power	Purchase Green-e certified renewable energy certificates for 35% of total energy demand	Reference the prescriptive renewable energy systems requirement exclusion for projects which purchase Green-e energy of at least 7 kWh/ft2 of conditioned space each year until the cumulative purchase is equal to 70 kWh/ft2 of conditioned space.	Nothing explicitly about green power however measures exist on calculating annual energy use and electric power. Provisions on solar electric power, wind power systems, and other renewable energy electric production systems. See renewable energy section.	No mandatory provision, however per A5.211.3 Green power (Tier 1 and Tier 2): Participate in the local utility's renewable energy portfolio program that provides a minimum of 50 percent electrical power from renewable sources. Maintain documentation through utility billings.	
	Moisture Control	Not directly addressed with exception of moisture control during construction and adequate air ventilation rates.	Not directly addressed with exception of moisture control during construction and adequate air ventilation rates.	Provisions for a moisture control plan and moisture control during the construction phase. Additional project elective provisions exist with inspections and compliance for foundation sub-soil drainage systems, foundation damp-proofing and water-proofing, flashing, exterior wall coverings, and roof coverings.	References CA building and energy code requirements for moisture control (1403.2 - Weather Protection and 150 - Mandatory Features and Devices).	
	Demand Response	No direct relationship, however indirectly credited through CACI when utility rates encourage off peak usage.	Requires demand limiting/shifting automatically to reduce peak demand by 10% or greater.	Detailed provisions for an open and interoperable automated demand response (Auto-DR) infrastructure. Provisions for demand response automation server (DRAS), HVAC systems, rebound avoidance (to prevent rebound peak), lighting, and building component-specific strategies.	No mandatory provision, however per A5.204.3 Demand response. HVAC systems with Direct Digital Control Systems and centralized lighting systems shall include preprogrammed demand response strategies that are automated with either a Demand Response Automation Internet Software Client or dry contact relays. Capacity to shed load by cooling temperature set point adjustment and total lighting load by a minimum 30 percent through dimming control or bi-level switching.	
		LEED 2009	**ASHRAE 189.1-2009**	**IGCC-PV1**	***CAL*Green 2010**	**SF Green Building Ordinance**
Materials and Resources	*Recyclable Collection*	Provisions for providing a dedicated area for recyclable collection and storage, but also includes provisions to maintain existing building structure and envelop and/or existing interior nonstructural elements	Provisions for providing a dedicated area for general recyclable collection and storage, but also has requirements for collection and storage of discarded but clean items in good condition (for projects with residential spaces), and fluorescent and HID lamps and ballasts for proper disposal	Provisions for providing a dedicated area for recyclable collection and storage	Provisions for providing a dedicated area for recyclable collection and storage	Provisions to provide systems for convenient separation for recycling, composting and trash storage. Provisions for collection, storage, and loading.
	Construction Waste	Provisions to recycle and/or salvage nonhazardous construction and demolition debris (at least 50% or 75%)	Provisions for waste diversion (minimum of 50%), and also limits the amount of generated waste (less than 42 yrd^3 or 12,000 lbs./10,000 ft^2)	Requires at least 35% of construction waste materials be diverted from landfills, and allows the jurisdiction to increase the materials required to be diverted by 50% or 65%. Project elective to increase material diversion from landfill by 20%.	CALGreen indicates that either a construction waste management plan needs to be established, or the local waste management ordinance must be met, whichever is more stringent, and requires extensive documentation. Like ASHRAE 189.1, at least 50% of nonhazardous construction and demolition debris needs to be recycled and/or salvaged	Required LEED points to be increased by 10% if demolished building was a historical resource. Director to determine on case-by-case basis when using other green building rating system. Provisions for diversion of at least 75% of the project's construction debris. (LEED MR2.2).
	Reused Materials	Provisions to use salvaged, refurbished or reused materials, the sum of which constitutes at least 5% or 10%, base on cost, of the total value of materials on the project	No provisions	Provisions to use salvaged, refurbished or reused materials, the sum of which constitutes at least 55% based on mass or cost.	No mandatory provisions, but voluntary provisions are the same as the 5% LEED requirement	Through January 1, 2011 one additional credit to be achieved under LEED MR3 (Reused Materials), MR4 (Recycled Content), MR5 (Regional Materials), MR6 (Renewable Materials), or MR7 (Certified Wood). Effective January 1, 2012 two additional credits in accord with the above LEED sections are required. Re-use or restoration of certain "character defining" features of historical features will be granted additional points or credits.
	Recycled Content	Provisions to "Use materials with recycled content such that the sum of postconsumer recycled content plus 1/2 of the pre-consumer content constitutes at least 10% or 20%, based on cost, of the total value of the materials in the project."	Same as LEED, but only 10% is required.	Provisions that "recycled content materials must contain at least 25% combined post-consumer and pre-consumer recovered material, and must be recyclable."	No mandatory provisions, but voluntary provisions require the use of either pre-consumer or post-consumer material (10% or 15% of total material cost, Tier 1 and Tier 2, respectively)	Through January 1, 2011 one additional credit to be achieved under LEED MR3 (Reused Materials), MR4 (Recycled Content), MR5 (Regional Materials), MR6 (Renewable Materials), or MR7 (Certified Wood). Effective January 1, 2012 two additional credits in accord with the above LEED sections are required.
	Regional Materials	Provisions to use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% or 20%, based on cost, of the total materials value	Same as LEED, but 15% is required	Provisions to us materials recovered, harvested, extracted and manufactured within 500 miles of the site, with special provisions for materials transported by water or rail.	No mandatory provisions, but voluntary provisions are similar to LEED, but 10% is required	Through January 1, 2011 one additional credit to be achieved under LEED MR3 (Reused Materials), MR4 (Recycled Content), MR5 (Regional Materials), MR6 (Renewable Materials), or MR7 (Certified Wood). Effective January 1, 2012 two additional credits in accord with the above LEED sections are required.
	Renewable Materials	Provisions to use rapidly renewable building materials and products for 2.5% of the total value of all building materials and products used in the project, based on cost.	Provisions to use a minimum of 5% (based on cost) bio-based products	Provisions for the bio-based content to be at least 50%, wood and wood products other than salvaged or reused wood products to be labeled, and follow USDA requirements.	No mandatory provisions, but voluntary provisions are the same as LEED	Through January 1, 2011 one additional credit to be achieved under LEED MR3 (Reused Materials), MR4 (Recycled Content), MR5 (Regional Materials), MR6 (Renewable Materials), or MR7 (Certified Wood). Effective January 1, 2012 two additional credits in accord with the above LEED sections are required.
	Recyclable Materials	No provisions	No provisions	Provisions for building materials to be manufactured for recyclability with minimum recovery rate of at least 30% (through recycling and reprocessing).	No mandatory provisions, but voluntary provisions exist	
	Certified Wood	Provisions to use a minimum of 50% (based on cost) of wood-based materials and products that are certified in accordance with the Forest Stewardship Council's principles and criteria, for wood building components (include at a minimum, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes).	Requires that wood building components cannot contain less than 60% certified wood content	Provisions for wood products to be labeled in accordance with the SFI Standard, FSC Indicators of Sustainable Forestry, PEFC Council Technical Document or equivalent fiber procurement system. As an alternative to an on-product label, a Certificate of Compliance indicating conformance with the fiber procurement system shall be permitted. Manufacturer's fiber procurement systems to be audited by accredited third-party.	No mandatory provisions, but voluntary measure indicates that the CBSC will continue to develop a standard through the next code cycle	Through January 1, 2011 one additional credit to be achieved under LEED MR3 (Reused Materials), MR4 (Recycled Content), MR5 (Regional Materials), MR6 (Renewable Materials), or MR7 (Certified Wood). Effective January 1, 2012 two additional credits in accord with the above LEED sections are required.
	Life-Cycle Assessment	No provisions	For the performance option, a LCA needs to be performed for a minimum of 2 building alternatives, and the building alternative chosen for the building project needs to have a 5% improvement over the other building alternative.	Section 304 indicates steps for an optional whole building LCA. No mandatory provisions.	No mandatory provisions, but voluntary measure section A5.409 indicates that materials assemblies should be selected based on life cycle assessment of their embodies energy and/or green house gas emission potentials	
	Policy	No provisions	No provisions	Provisions under Environmental Stewardship Criteria (section 303.3) require any jurisdiction in which other rules and regulations are applicable, under 1) Clean air, 2) Clean water, 3) Conservation, and 4) Noise control, the more stringent of the requirements are to apply. Specific policies under each are listed.	No provisions	

Service Life	No provisions	No provisions	Provisions for a Building Service Life Plan be included in the construction documents for the project and provides detailed requirements for the plan. Voluntary provisions to increase building service life to 200 years or 100 years.	No mandatory provisions, but voluntary provisions exist	
Architectural Efficiency	No provisions	No provisions	No mandatory provisions, but voluntary provisions exist.	No provisions	

Environmental Quality	LEED 2009	ASHRAE 189.1-2009	IGCC-PV1	*CAL*Green 2010	SF Green Building Ordinance
Outdoor Air	Prerequisite provisions establishing ventilation requirements per ASHRAE 62.1. To achieve the credit, either mechanical ventilation needs to be increased by 30% or show that naturally ventilated spaces meet CIBSE requirements.	Ventilation requirements also established using methods indicated in ASHRAE 62.1	Provisions for building ventilation during construction and building flush out provisions after construction.	"For mechanically or naturally ventilated spaces in buildings, the requirements of Section 121 of the CEC, CCR, Title 24, Part 6 or the applicable local code (whichever is more stringent) and Chapter 4 of CCR, Title 8, need to be met. CO2 monitoring is required for demand control ventilation.	
Tobacco Smoke	Smoking is not allowed in buildings (unless there are designated smoking areas) and smoking 25 ft. from envelope openings is prohibited. Signage required	Similar to LEED in the signage and 25 ft. requirement, but also specifies that signage needs to be posted within 10 feet of entryways. Smoking not allowed in all buildings.	Provisions for the design of building spaces and HVAC systems for jurisdictions which permit tobacco smoking by the occupants within buildings or tenant spaces.	Also has a 25 ft. provision (or local regulation, whichever is more stringent). When ordinances, regulations, or policies are not in place, signage should be posted to inform building occupants of the prohibitions.	
Outdoor Air Monitoring	Provisions for a permanently installed outdoor air monitoring system that generates an alarm if outdoor air or CO2 levels exceed a 10% deviation from design values	Provisions are similar to LEED except that the monitoring system needs to be capable of measuring flow within an accuracy of ± 15% of the minimum outdoor air flow rate (not 10%).	Does not explicitly state the requirements for outdoor air monitoring or the accuracy of measurement devices.	Does not explicitly state the requirements for outdoor air monitoring or the accuracy of measurement devices. Though cross-reference to energy code.	
During Construction	Provisions for the development of an IAQ management plan for the construction and pre-occupancy phases of the project. Must meet or exceed SMACNA control measures, protect stored absorptive materials from moisture damage, and if permanently installed air handlers are used during construction then a filter of at least MERV 8 needs to be installed, then replaced prior to occupancy.	IAQ Management Plan is required, along with moisture protection of absorptive materials, and restricted idling of construction vehicles.	Provisions for building ventilation during construction.	Mandatory provisions for the covering of duct openings and protection of mechanical equipment during construction. Voluntary measures are similar to LEED in stringency.	
Before Occupation	EQ Credit 3.2 requires the development of an IAQ management plan for pre-occupancy. Dilution through ventilation is the primary strategy.	Building flush-out or IAQ testing required. Effectively equivalent to LEED requirements.	Provisions to "flush out" the building after construction.	No mandatory provisions for pre-occupancy IAQ management, but voluntary measures also includes a plan to "flush out" the building.	
Adhesives / Sealants	All adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following requirements as applicable to the project scope: - Adhesives, Sealants and Sealant Primers must comply with South Coast Air Quality Management District (SCAQMD)	All adhesives and sealants used on the interior of the building (inside of the weather-proofing system and applied on-site) needs to comply with the emissions requirements of California Section 01350, and VOC contents should comply with SCAQMD Rule 1168 or Green Seal Standard GS-36.	A minimum of 85% by weight or volume, of applied adhesives and sealants, to comply with VOC content in accordance with the appropriate standard being either U.S. EPA Method 24, SCAQMD Method 304, 316A or 316B.	Similar to ASHRAE 189.1.	Provisions same as LEED.
Paints / Coatings	Limits the VOC content of paints and coatings based on certain standards	Limits the VOC content of paints and coatings based on certain standards	Limits the VOC content of paints and coatings based on certain standards. Alternative emissions testing to be performed by laboratory that has the CA/DHS/EHLB/R-174 test methodology in the scope of its ISO 17025 Accreditation.	Limits the VOC content of paints and coatings based on certain standards and explicitly states the need to verify compliance through documentation	Provisions same as LEED.
Flooring / Carpet	Provisions for carpet that is tested and compliant to certain standards. All hard surface flooring needs to be compliant with FloorScore standards.	Carpet and hard surface flooring in office spaces need to comply with California Section 01350	Provisions for a minimum of 85% of the total area of flooring installed within the interior of the building to comply with listed product and for flooring with more than one distinct product the emissions from each layer to comply with requirements. The emissions testing shall be performed by a laboratory that has the CA/DHS/EHLB/R-174 test methodology in the scope of its ISO 17025 Accreditation.	Carpet needs to comply with California Section 01350 or one of 3 other standards. 50% of resilient flooring systems needs to be compliant with FloorScore standards.	Provisions same as LEED.
Composite Wood	Composite wood and agrifiber products used on the interior of the building (i.e., inside the weatherproofing system) cannot contain added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies cannot contain added urea-formaldehyde resins.	Also prohibits urea-formaldehyde resins. Emissions need to comply with a) third party certification submitted indicating compliance with California Air Resource Board's (CARB) regulation b)CA/DHS/EHLB/R-174 and comply with limit requirements for either office or classroom spaces regardless of space type	Interior particleboard, hardwood plywood, and medium density fiberboard used as sub-flooring and decorative wall coverings, and in permanently installed millwork to be rated for exterior exposure in accordance with DOC PS 1 or DOC PS 2. Compliance shall be demonstrated following the requirements of Section 93120 of title 17, California Code of Regulations, Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products.	Formaldehyde in composite wood needs to conform to limits specified in ARB's Air Toxics Control Measure for Composite Wood (17 CCR 93120 et seq.). Urea-formaldehyde resins are not prohibited.	
Pollutant Isolation	Credit requirements include an entryway system (at least 10 feet long). Sufficiently exhausting of spaces where hazardous gases or chemicals may be present or used is required. In mechanically ventilated buildings, air filters must be a minimum of MERV 13. Hazardous liquid waste containment also required.	Provisions require all building entrances to employ an entry mat system that has a scraper surface, absorption surface, and a finishing surface. Each surface should be a minimum width of the entry opening (lengths: scraper - 3 ft., absorption - 3 ft., finishing - 4 ft.)	Provisions for enclosed rooms or spaces greater than 200SF in area (used as print or copy facility, janitorial room, repair garage or aircraft hangar) where chemical use occurs. 1) walls to constructed to resist passage of airborne chemical pollutants. 2) doors to be automatic or self-closing. 3) HVAC system provides separate exhaust airflow to outdoors at rate of not less than 0.50 cfm per SF; maintains negative pressure of not less than 7pa within the room; and prohibits recirculation of air from room to other portions of the building.	No mandatory provisions, but voluntary measures specify the need for entryway systems that minimize and control pollutant entry (lift in direction of travel)	
Controllability	Credits have provisions for controllability of lighting and systems for thermal comfort	It is specified that thermal comfort needs to be met, but there are no provisions for controllability	Provisions for controllability of lighting and systems for thermal comfort.	No mandatory provisions exist, but voluntary measures address the issue of controllability of lighting and systems for thermal comfort	
Thermal Comfort	Provisions to meet thermal comfort criteria established by ASHRAE Standard 55 and to verify through occupant survey	Provisions to design the building in compliance with ASHRAE Standard 55	"to the extent that is feasible" meet thermal comfort criteria established by ASHRAE 55 and 62.1	No provisions to design to meet a certain level of thermal comfort, but voluntary measures address controllability for the purposes of thermal comfort	
Daylight	Performance Option: Perform simulation to show that at least 75% of regularly occupied areas achieve daylight illuminance of at least 25 fc	Performance Option: Perform simulation to show that at least 75% of daylight zones achieve daylight illuminance of at least 30 fc at 3 ft. above the floor	Contains requirements for the day lighting of interior spaces, including both prescriptive and performance based methods. Performance requirement: all points in the daylight area have a daylight saturation of not less than 60 percent.	No mandatory provisions, but voluntary provisions exist that reference CA Energy Code requirements for top lighting and side lighting.	
Views	Provisions for line of sight for purposes of maximizing view.	No provisions	Project elective provisions for line of sight for purposes of maximizing view.	No mandatory provisions exist, but voluntary measures address the issue of line of sight	
Acoustics	No provisions	Specifies acoustical ratings of building envelope and interior wall and floor-ceiling assemblies for different building and space types	Specifies acoustical ratings of building envelope and interior wall and floor-ceiling assemblies.	Exterior sound provisions are the same as ASHRAE 189.1, but interior sound does not break down acoustical rating requirements by space type	
Radon	No provisions	Radon: Building projects that include construction or expansion of a ground-level foundation and which are located on brownfield sites or in "Zone 1" counties identified to have a significant probability of radon concentrations higher than 4 picocuries/liter on the USEPA map of radon zones, shall have a soil gas retarding system installed between the newly constructed space and the soil.	Provisions for radon mitigation exist where building projects are in "Zone 1" counties.	No provisions	
Fireplace	No provisions	No provisions	Provisions provided for fireplace installation, ventilation, gas fireplacers, and wood-burning fireplaces.	Provisions limit fireplace type and indicates that they must comply with local ordinances	
Air Filtration	To achieve the pollutant source control credit, mechanically ventilated buildings are required to have air filters that have a minimum of MERV 13	Provisions to provide filters of at least MERV 8 and should comply with and be provided where required in Section 5.9 of ASHRAE Standard 62.1, and to provide filters of at least MERV 13 in a site designated "non-attainment".	During construction filters for ducted systems to be rated at MERV 13 or higher and filters for ducted space conditioning systems to have a minimum MERV rating of 6 is required.	Like ASHRAE 189.1, a minimum MERV rating of 8 is required (voluntary measure requires a MERV rating of 11)	
Ozone / GHG	Prohibits use of CFC-based refrigerants in new building base HVAC&R systems. Credits includes 2 options: not using refrigerants, or using refrigerants that minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change.	Like LEED, CFC-based refrigerants are prohibited	Like ASHRAE 189.1, CFC-based refrigerants are prohibited. Provision that prohibits Halons. Voluntary measures match LEED in stringency.	Like ASHRAE 189.1, CFC-based refrigerants are prohibited. Provision that prohibits Halons. Voluntary measures match LEED in stringency.	
Moisture Control	Not directly addressed with exception of moisture control during construction and adequate air ventilation rates.	Not directly addressed with exception of moisture control during construction and adequate air ventilation rates.	Moisture control provisions during the construction phase. Project elective (voluntary) provisions exist for moisture preventative measures and inspection procedures.	Provision to meet or exceed the provisions of California Building Code, CCR, Title 24, Part 2, Sections 1203 (Ventilation) and Chapter 14 (Exterior Walls). Additional mandatory measures provide moisture control by specifying design of sprinklers and entries/openings.	

Commissioning and Building Operations	LEED 2009	ASHRAE 189.1-2009	IGCC-PV1	*CAL*Green 2010	SF Green Building Ordinance
Owner's Requirements Acceptance	Provisions for an owner's project requirements document Requirement of a commissioning authority and specifies commissioning activities (OPR and BOD review, development and implementation of a commissioning plan, etc.)	Provisions for an owner's project requirements document Similar requirements to LEED, but does not specify that the commissioning authority must have documented commissioning authority experience in at least 2 building projects. Requires an OPR, BOD commissioning plan, and documentation, but not training or a commissioning report	Provisions for an owner's project requirements document Requirement of a commissioning authority and specifies commissioning activities	Provisions for an owner's project requirements document Does not have provisions for a commissioning authority, but requires an OPR, BOD, commissioning plan, documentation and training, and a commissioning report	
Commissioning Systems	The following systems need to be commissioned at a minimum: 1. HVAC and associated controls 2. Lighting and day lighting 3. Domestic hot water systems 4. Renewable energy systems	The following systems need to be commissioned: **1. HVAC systems and controls** 2. IAQ systems and controls 3. Refrigerant systems and controls 4. Building envelope to verify thermal and moisture integrity, as well as air-tightness **5. Lighting** and shading controls **6. Irrigation systems** **7. Plumbing systems** 8. Domestic and process water pumping and mixing systems **9. Service water heating systems** **10. Renewable energy systems** 11. Water measurement devices 12. Energy measurement devices	The following systems need to be commissioned: 1. Energy Systems 2. Lighting and electrical systems 3. Building envelope systems	The following systems need to be commissioned: 1. HVAC systems and controls 2. Indoor and outdoor lighting and controls 3. Water heating systems 4. Renewable energy systems 5. Landscape irrigation systems 6. Water reuse systems	
Measurement, Verification & Operation	Provisions for a measurement and verification plan covering at least 1 year of occupancy that ensures that the modeled energy savings is being achieved	Requires a building operating plan that includes measurement and verification of water use, energy use, energy efficiency, IEQ, outdoor air, and plans to maintain vegetation on the site. Water and energy use needs to be tracked and assessed at least every three years.	Requires measurement and verification of energy use and energy efficiency.	Does not have provisions for measurement and verification of energy in mandatory measures, but does include metering of water use. Voluntary measures speak generally to energy monitoring without degree of specificity contained in 189.1.	Provisions for permit applicant "documentation to verify renewable on-site energy or purchase green energy credits in accord with LEED® EA2 or EA6." (Not effective until January 1, 2012
Documentation	Provisions for a systems manual, commissioning report and specifications	The owner retains the System Manual, the Final Commissioning Report, and measurement and verification documentation	Provisions for a systems manual, commissioning report and specifications	Like with ASHRAE 189.1, the owner is given the systems manual and final commissioning report.	Provisions for a systems manual, commissioning report and specifications
Maintenance Manual	The commissioning authority ensures that personnel are trained using the systems manual	Requires a maintenance plan, service life plan, and transportation management plan. Additionally, high performance building operation plans for site, water, M&V, energy, and IEQ.	Requires a maintenance plan, service life plan, energy conservation, automatic demand reduction systems, equipment.	Provisions for an operation and maintenance manual, and training personnel using the systems manual	Provisions exist for building maintenance.