Titus
Redefine your comfort zone.™

LEED™ & Green Buildings
APPLICATION GUIDE

U.S. GREEN BUILDING COUNCIL MEMBER®

contents

LEED™ and Green Buildings Application Guide

General
This document provides application highlights covering green buildings.

Introduction
The increased interest and demand for green buildings continue in building projects. This document highlights some areas where using Titus products may help to achieve the goal of becoming a certified green building project.

Leadership in Energy & Environment
The United States Green Building Council (USGBC) developed the Leadership in Energy & Environmental Design (LEEDTM) Green Building Rating System™. The LEED council is a voluntary, consensus-based national standard board for developing high-performance, sustainable buildings. USGBC members represent all segments of the building industry and update the program continuously.

Purpose
The LEED rating system was created for
the following reasons:

- Define "green building" by establishing a common measurement standard
- Promote integrated, whole building design practices
- Recognize environmental leadership in the building industry
- Stimulate green competition
- Raise consumer awareness of green building benefits
- Transform the building market

More information about the USGBC and LEED can be found on the USGBC website (www.usgbc.org).

LEED Rating System
Using the LEED rating system, a project can become LEED certified by obtaining points for green building processes, systems, and materials. The four levels of LEED certification are as follows.

- General certification requires 40-49 points
- Silver certification is 50-59 points
- Gold certification is 60-79 points
- Platinum certification is 80+ points

There are four different LEED rating systems. This guide will discuss the LEED Building Design & Construction (BD+C) Rating System. The other rating systems are Interior Design & Construction (ID+C), Building Operations & Maintenance (O+M), and Neighborhood Development (ND).

LEED BD+C applies to new construction, core and shell, schools, retail, data centers, warehouses and distribution centers, hospitality, and healthcare. Most credits apply to all of these applications, but there are also some application specific credits.

Points are awarded in various categories. The following list provides the section categories.

- Integrative Process
- Location & Transportation (LT)
- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy & Atmosphere (EA)
- Material & Resources (MR)
- Indoor Environmental Quality (EQ)
- Innovation (IN)
- Regional Priority (RP)

Prerequisites and Credits exist within each section. To achieve LEED certification, prerequisites for all sections of LEED must be met regardless of which Credits are submitted for certification. The following table lists credits and prerequisites related to air distribution.

Table 1. Prerequisites and Credits Related to Titus Products

LEED Category	Points
Energy & Atmosphere	
» Prerequisite – Fundamental Building Systems Commissioning & Verification	Required
» Prerequisite – Minimum Energy Performance	Required
» Prerequisite – Building Level Energy Metering	Required
» Prerequisite - Fundamental Refrigerant Management	Required
» Credit - Enhanced Commissioning	2 - 6
» Credit - Optimize Energy Performance	1 - 20
Materials & Resource	
» Prerequisite – Storage & Collection of Recyclables	Required
» Prerequisite – Construction & Demolition Waste Management Planning	Required
» Prerequisite - PBT Source Reduction - Mercury	Required
» Credit – Building Product Disclosure and Optimization - Environmental Product Declarations	1 – 2

LEED Category	Points
» Credit – Building Product Disclosure and Optimization - Sourcing of Raw Materials	1 - 2
Indoor Environmental Quality	
» Prerequisite – Minimum IAQ Performance	Required
» Prerequisite – Environmental Tobacco Smoke (ETS) Control	Required
» Prerequisite - Minimum Acoustic Performance (Schools only)	Required
» Credit – Enhanced Indoor Air Quality Strategies	1-2
» Credit – Thermal Comfort	1
» Credit – Acoustic Performance	1
Innovation & Design Process	
» Credit – Innovation in Design	1

On top of these prerequisites a building must meet some minimum requirements, such as being a permanent building that serves at least one full time occupant, be at least 1000 sq.ft. in size, and have a building to site ratio of greater than 2%. LEED certified buildings must also share their whole building energy and water data with the USGBC.

Energy & Atmosphere

Enhanced Commissioning

This credit is for implementing additional independent commissioning process activities in addition to the requirements of EA Prerequisite 1 Mechanical, electrical, plumbing, and renewable energy systems are covered by this credit.

The commissioning authority must do the following:

- Review contractor submittals
- Verify inclusion of systems manual requirements in construction documents
- Verify inclusion of operator and occupant training requirements in construction documents
- Verify systems manual updates and delivery
- Verify operator and occupant training delivery and effectiveness
- Verify seasonal testing
- Review building operations 10 months after substantial completion
- Develop an on-going commissioning planTo simplify the collection of product manuals, many of Titus' products have QR labels on the unit itself that link directly to the products' Installation & Operation Manual (IOM).

Also consider air balancing the diffusers, registers, and grilles as part of the additional commissioning tasks of the building systems.

Optimize Energy

The intent of this credit is to reduce the energy usage of the building below the ASHRAE Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings, prerequisite requirement.

There are two methods of achieving this credit. The first, and currently most common, method is based on percentage of reduction and range from 5% reduction (1 Point) to 50% reduction (18 Points) for new construction. Two additional points can be achieved for healthcare buildings. The percent reduction is determined by completing a whole building energy simulation.

The second method of achieving this credit is to comply with the Prescriptive Compliance Path in the ASHRAE Advanced Energy Design Guide. Using this method, you can achieve up to 6 points.

UnderFloor Air Distribution Systems

One way to achieve energy optimization credit is with an underfloor air distribution (UFAD) system. UFAD systems may have higher HVAC equipment efficiency as access floor air systems use warmer supply air (60° to 65°F) than conventional systems that use 55°F supply air. Raising the discharge temperature of many system types reduces energy consumption.

UFAD systems can move a larger volume of air with overall lower pressure drops. The underfloor plenum needs less than 0.1 inch of water pressure for proper diffuser performance. This results in less fan horsepower needed for UFAD systems resulting in lower energy usage.

The energy savings of an UFAD system should be considered as part of the system to receive an Optimize Energy Performance credit.

Displacement Ventilation Systems

Displacement ventilation systems use the natural buoyancy of warm air to provide improved ventilation and comfort. Cold air from a displacement diffuser moves slowly across the floor until it reaches a heat source, such as a person or a computer, then rises. Displacement ventilation systems cannot be used for heating however, so a supplementary heating system is required.

The system design of a displacement ventilation system is very similar to a UFAD system. Therefore it can help achieve the Optimize Energy Performance credit.

Chilled Beam Systems

Chilled beam systems are water based cooling systems. Because cooling with water is more efficient than cooling with air, these systems can save

energy and help achieve the Optimize Energy Performance credit.

There are two types of chilled beams, passive and active. Both types use convection of room air over a cooling or heating coil to maintain comfort. A passive chilled beam does not have a supply air inlet. Fresh air must be supplied through a separate fresh air system. Active chilled beams have a supply air inlet. In either system, the airside volume is much lower than in an all air systems. This reduces the fan size and therefore reduces the fan energy usage.

ECM Motors

ECM motors are another option that should be considered for the Optimize Energy Performance credit. The ECM motor has efficiencies of up to 70% across its entire operating range (300-1200 rpm) and 80% over 400 rpm. The ECM motor is available in all Titus fan-powered terminals. See the ECM Application Guide, AG-ECM, for more information.

Auto-Changeover Perimeter Diffuser

Most perimeter areas of commercial buildings require both heating and cooling. Typically a split overhead system uses two slot diffusers mounted end to end or one diffuser with multiple slots. In the two diffuser system, one diffuser is set for horizontal discharge and the other for vertical. With a multiple slot diffuser, half of the slots are set to discharge horizontally and half discharge vertically.

Even though these methods work, they are not the optimum solution. In both the heating and cooling modes, half the supply air is being discharged in the wrong direction. During heating, half the air is discharged horizontally which causes stratification along the ceiling. In cooling, half the air is discharged vertically causing unwanted drafts along the floor.

The Titus EOS was designed to solve the perimeter challenge. The EOS automatically changes the air discharge pattern to the correct position for heating and cooling applications. This allows 100% of the supply air to be utilized in either application to achieve optimum comfort in the occupied zone. Lab tests have shown that the return temperature was 3.25°F lower using an auto-changeover diffuser, compared to a split flow perimeter slot diffuser. This equates to a saving of 26.5% of energy by not directing warm supply air directly to the return.

The EOS not only increases the comfort level by correctly discharging supply air in both heating and cooling modes, it does so without the use of an external power source which translates to energy savings for the building owner. When 100% of the supply air is utilized, the room temperature reaches the set-point faster requiring the HVAC system to run for a shorter duration of time, which saves energy. In fact, preliminary lab tests indicate energy savings to be 10-40%, which can help achieve the Optimize Energy Performance credit.

Material & Resources

Building Product Disclosure and Optimization - Environmental Product Declarations

The intent of this credit is to encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts. To reward project teams for selecting products from manufacturers who have verified improved environmental life-cycle impacts. This credit covers the regional material topic, which had its own credit in previous versions of LEED.

Titus manufactures product all over the country. Whenever possible consider product manufacturing plant location when selecting products.

Building Product Disclosure and Optimization - Sourcing of Raw Materials

The intent of this credit is to encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts. To reward project teams for selecting products from manufacturers who have verified improved environmental life-cycle impacts. This credit covers the recycled content topic, which had its own credit in previous versions of LEED.

Titus' EcoShield liner is made of 85% post-industrial recycled cotton. EcoShield may also be used throughout the ductwork on the project.

Indoor Environmental Quality

Enhanced Indoor Air Quality Strategies

The intent of this credit is to promote occupants' comfort, well-being, and productivity by improving indoor air quality. Option 2 of this credit discusses increased ventilation.

Increasing the ventilation rates to all occupied spaces by at least 30% over ASHRAE 62.1-2010, Ventilation for Acceptable Indoor Air Quality, as required by the Minimum IAQ Performance prerequisite will help achieve this credit.

Displacement ventilation systems can help achieve the increased ventilation credit. ASHRAE Standard 62.1, table 6-2, Zone Air Distribution Effectiveness, rates the air distribution effectiveness of a displacement ventilation system as 1.2. The zone air distribution effectiveness is a measure of how effectively the zone air distribution uses its supply air to maintain acceptable air quality in the breathing zone.

A rating of 1.2 is essentially equivalent to stating that a displacement ventilation system requires 20% less fresh air than an overhead cooling system which has a rating of 1.0, or in terms of the Increased Ventilation

credit, that 20% of the 30% required is achieved by default when a displacement ventilation system is utilized. This means that less actual fresh air is required to achieve this credit.

For heating, the perimeter overhead heating systems must be sizes correctly to achieve a zone air distribution effectiveness of 1.0. If a split overhead system is being used, proper selection of the overhead perimeter slot diffuser throw is necessary to ensure that fresh air is provided to the occupied zone in both cooling and heating modes.

The diffuser should be selected so that the isothermal (cataloged) data for the 150 fpm throw reaches the 4 ft level from the floor of the occupied space and the supply air does not exceed 15°F over the zone temperature. If the diffuser is not selected in this manner, the zone air distribution effectiveness becomes 0.8 and additional fresh air will need to be supplied to the zone.

Bringing in additional outside air in the heating season will also increase energy usage due to the need to heat up the cold outside air before supplying it to the zone. The EOS can solve this issue be putting the air where it needs to be in both cooling and heating seasons.

Thermal Comfort

This credit requires that the building comply with ASHRAE Standard 55-2010, Thermal Comfort Conditions for Human Occupancy for the thermal comfort design portion and provide at least 50% of the occupants with individual comfort controls for the thermal comfort control portion.

It has been shown that individual comfort is maintained when the following conditions are maintained in a space:

- Air temperature maintained between 73-77°F
- Relative humidity maintained between 25-60%
- Maximum air motion in the occupied
- 50 fpm in cooling
- 30 fpm in heating
- Floor to 6-foot level, 5-6°F maximum temperature gradient

The ASHRAE comfort standard states that no minimum air movement is necessary to maintain thermal comfort, provided the temperature is acceptable. To maximize energy conservation, we should attempt to maintain proper temperatures at the lowest possible air speed. The ASHRAE comfort charts, Figures 2 and 3 show the relationship between local air velocity and temperature difference in the ankle and neck regions.

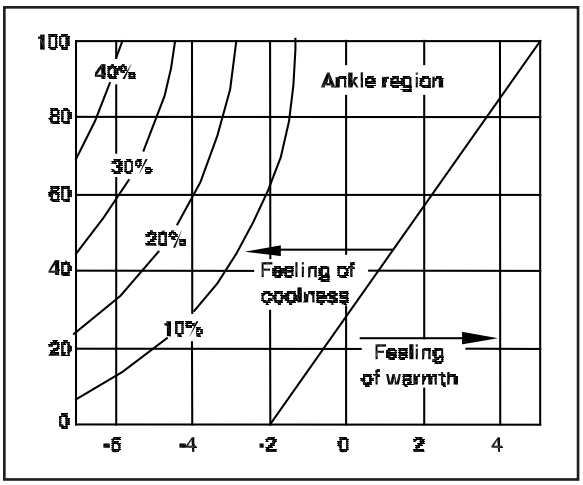

Figure2 - Ankle Region Comfort Chart

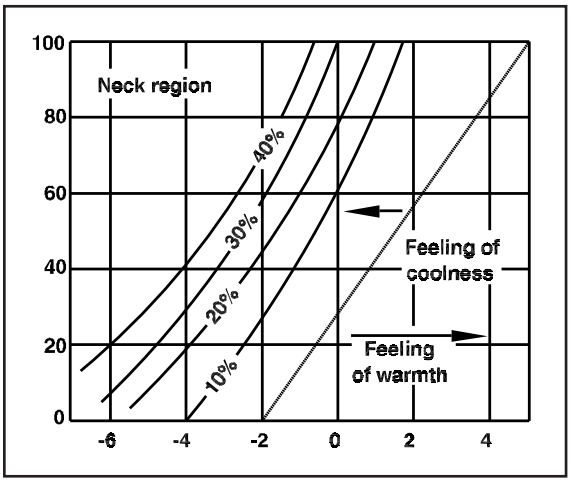

Figure3 - Neck Region Comfort Chart

Although the occupied zone's velocity and temperature is important in all HVAC systems, access floor systems require careful consideration as the air is introduced directly into the occupied zone. The ability of the access floor diffuser to rapidly mix room air into the supply air at low velocities is the key to success. Slowing the supply air down 50 fpm and warming it up to 75°F as close to the diffuser face as possible provides the most occupant comfort. A typical access floor diffuser should reach the 50 fpm and 75°F point within a 1 to 2 foot radius from the center of the diffuser. As the radius increases to reach the 50 fpm and 75°F point, the usable floor space decreases.

For the individual comfort control portion of the credit, VAV diffusers, such as the Titus T3SQ and UFAD diffusers, such as the TAF-R, would help achieve this credit.

Acoustic Performance

The intent of this credit is to provide workspaces and classrooms that promote occupants' well-being, productivity, and communications through effective acoustic design. It sets requirements for HVAC background noise, sound isolation, reverberation time, and sound reinforcement and masking, where applicable.

The credit sets maximum HVAC background noise levels per 2011 ASHRAE Handbook, HVAC Applications, Chapter 48, Table 1; AHRI Standard 885-2008, Table 15; or a local equivalent.

Selecting and sizing terminal units, grilles, and diffusers can help you achieve acceptable sound levels in the occupied space.

Green Building Codes and Programs

With energy considerations growing, there is an increased interest in green buildings, sustainable design, and energy savings. Although the U.S. Green Building Council is not a government agency, many local governing bodies are requesting, and in some cases requiring, green design features into their new construction requirements.

Federal Green Requirements

All new GSA building projects must meet criteria for basic LEED certification. The Department of State has committed to using LEED on the construction of new embassies worldwide over the next 10 years. All of EPA's significant new facility construction and new building acquisition projects are required to meet the U.S. Green Building Council's LEED Silver standard.

The Air Force has developed a LEED Application Guide for Lodging projects and has conducted LEED training seminars for its design and construction personnel. The Air Force encourages the use of LEED for new or major renovations for military construction projects and has created an online design guide for sustainable development structured after LEED. The Army has adopted LEED into its Sustainable Project Rating Tool.

The Navy encourages sustainable development in its facilities requiring all applicable projects to meet the LEED Certified level, unless justifiable conditions exist that limit accomplishment of the LEED credits necessary for achieving the Certified level. Submission to the USGBC for LEED certification is not a requirement, but is recommended for high visibility and showcase projects.

State Green Requirements

Many states have adopted green building standards for publicly funded projects. Many of the states not listed below are currently considering green buildings requirements.

- Arizona requires that all state-funded buildings meet at least the LEED Silver standard
- In California new buildings or major renovations larger than 10,000 square feet must earn LEED Silver and incorporate on-site renewable energy if economically feasible. The Green Building Action Plan further requires existing State buildings over 50,000 square feet to complete LEED-EB certification by December 31, 2015.
- Colorado requires new and renovated state buildings to attain LEED Gold certification and all state government agencies and departments are required to adopt the LEED rating system for existing and new buildings to ensure reductions in energy use to the extent practical and cost effective.
- Delaware requires that new construction and major renovation projects should be designed to meet or exceed the LEED Silver rating, and that third-party certification must be pursued for such projects if it can be accomplished at a reasonable cost.
- Florida requires all new state government buildings to meet LEED standards
- Hawaii requires newly constructed or substantially renovated state owned facilities to be built to LEED Silver standards
- In Kentucky, LEED certification is required for new buildings. The level of LEED certification depends on the project size and budget.
- Maryland requires all new fully State funded building projects, plus partially State funded K-12 schools and Community College buildings exceeding 7,500 square feet to meet LEED Silver
- Massachusetts requires that all state agency new construction and major renovations over 20,000 sq. ft. must meet the MA LEED Plus green building standard and perform 20% better than the state energy code
- Michigan requires the Department of Management and Budget to perform and oversee a number of tasks related to reducing energy use, including an assessment of the costs and benefits of using the LEED standard when constructing or renovating state buildings
- New Jersey requires that new buildings larger than 15,000 square feet constructed for the sole use of state entities achieve LEED Silver certification, a two-globe rating on the Green Building Initiative Green Globe rating system, or a comparable numeric rating from another accredited sustainable building certification program
- New Mexico requires LEED Silver standards for new public buildings

in excess of 15,000 square feet and/or using over 50kW peak electrical demand

- Oklahoma requires all new state-owned buildings or major renovations of state-owned buildings to meet LEED standards
- South Carolina requires newly constructed state buildings to meet either the LEED Silver standard or the Green Globes Rating System for construction
- South Dakota requires use of high performance building standards for new state construction and renovation projects costing more than $500,000 or more than 5,000 square feet of space. These standards must be at least as stringent as the LEED-Silver standard, the two-globe standard on the Green Globes rating system, or a comparable standard.
- Virginia requires that new or renovated state buildings should conform to LEED Silver or Green Globes two-globe standards
- Washington requires major state construction projects over 25,000 sq. ft. to be designed and built according to the LEED Silver standard

Summary

The green building concept has become more popular over the past couple of years. Owners are interested in saving money on energy costs while providing a comfortable working environment. State and local governments are implementing tax credits for energy efficient and environmentally friendly buildings.

More information about green buildings can be found on the Green Building section of the Titus website at (http://www.titus-hvac.com/main/Green%20Buildings) and on individual state websites and green building organizations' websites, such as the U.S. Green Building Council (www.usgbc.org), the American Council for and Energy-Efficient Economy (www.aceee.org), and many others. The EPA also has information on green buildings on its website http://www.epa.gov/greenbuilding/).

Abbreviations

The following table lists abbreviations used within this document.

ABBREVIATION	TERM
ADPI	Air Diffusion Performance Index
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
CFC	Chlorofluorocarbons
EA	Energy & Atmosphere
ECM	Electronically Commutated Motor
EPA	Environmental Protection Agency
EQ	Indoor Environmental Quality
ETS	Environmental Tobacco Smoke
F	Fahrenheit
FPM	Feet per Minute
GSA	General Services Administration
HP	Horsepower
HVAC	Heating Ventilation and Air Conditioning
HVAC&R	Heating Ventilation and Air Conditioning and Refrigeration
IAQ	Indoor Air Quality
ID	Innovation & Design Process
LEED	Leadership Energy and Environmental Design
MR	Materials & Resources
NYSERDA	New York State Energy Research and Development Authority
RPM	Revolutions per Minute
SS	Sustainable Site
USGBC	United States Green Building Council
VAV	Variable Air Volume
WE	Water Efficiency

Notes

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