VESTA
SUSTAINABLE CONSTRUCTION HANDBOOK
BUILDING SHELLS

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Bioconstrucción y energía alternativa

VESTA Sustainable Construction Handbook

Building Shells
Complementary Technical Regulations to be implemented along VESTA's current construction practices and standards for the construction or renovation of Industrial Building Shells.

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100 INTRODUCTION

110 Introduction to VESTA's Sustainable Construction Handbook: Building Shells

As designers and building owners learn that with a smart design, buildings can save energy, water and reduce their environmental impact, sustainable design and construction is becoming increasingly important in the construction industry.

Building owners, designers and builders are being challenged to develop facilities that are secure, productive, and healthy, with low operation cost and minimum impact on the environment.

VESTA's Sustainable Construction Handbook has been developed as a tool to support the company's vision of social and environmental responsibility. Based on international standards and regulations VESTA's Sustainable Construction Handbooks provide a framework to incorporate sustainable construction best practices on VESTA's real estate properties.

120 Background

VESTA is an Industrial Real Estate Fund, with more than ten years of experience in the development of industrial infrastructure: Industrial Parks, "Build to Suit" and Spec building for lease. VESTA currently owns 103 properties distributed in 11 states of Mexico.

VESTA's Project's Manual establishes technical specifications for the construction of the company's industrial buildings. VESTA's Sustainable Construction Handbooks (Industrial Parks & Building Shells) aim to integrate current standards and practices used by the company with international standards and regulations for sustainable development.

130 Relevance of VESTA's Sustainable Construction Handbooks

Through the development of VESTA's Sustainable Construction Handbooks, Industrial Parks & Building Shells, VESTA wishes to move forward in the achievement of its vision of social and environmental responsibility. This Handbook includes sustainable best practices and strategies for the construction, operation and maintenance of VESTA's industrial real estate properties.

This handbook's sustainability strategies focus on the development of:

- *Best practices for the selection and development of the site.*
- *Best practices for the achievement of energy efficiency.*
- *Best management practices for materials and resources.*
- *Development of a commissioning plan to verify that the project's energy-related systems are installed calibrated and performs as designed.*
- *Return of investment analysis for implementing eco-technologies.*

VESTA's initiative of developing Sustainable Construction Handbooks to incorporate sustainability principles in its industrial parks and building shells reinforces the company's commitment with the environment and society, contributing to strengthen the company's image before investor, strategic partners and potential clients.

140 Methodology

VESTA's Sustainable Construction Handbooks were developed following world renowned sustainability standards. The Handbooks are based on the requirements for LEED™ Core & Shell 2009 Certification, as well as standards established by institutions mentioned in the LEED™ Reference Guide for Green Building Design and Construction, such as ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) or EPA (Environmental Protection Agency). VESTA's Sustainable Construction Handbooks also take into account the requirements of the IGCC 2.0 (International Green Construction Code).

VESTA's Sustainable Construction Handbooks take as reference current standards and practices used by VESTA in the development of its industrial properties, incorporating additional sustainability strategies and best practices, which can be divided into six main categories:

- *Sustainable Sites*
- *Water Efficiency*
- *Energy and Atmosphere*
- *Renewable Energy*
- *Materials and Resources*
- *Indoor Environmental Quality*

141 Base Case Analysis

An existing building shell representative of VESTA's developments was taken as a baseline for analysis purposes. Savings will be determined by contrasting energy and water consumption of the baseline development with projected resource consumption of building shells were sustainable strategies are to be implemented.

141.1 *Vesta Inventory III Building*

Project Description: Vesta Inventory III Building is one of VESTA's leasable industrial properties, consisting on a 24,045.1 square meters building shell located in Parque Industrial Queretaro. The Inventory III Building includes the following exterior areas: loading docks, parking lot, truck maneuvering areas, landscaping and guard house.

Figure 1: Vesta Inventory III Building Aerial View

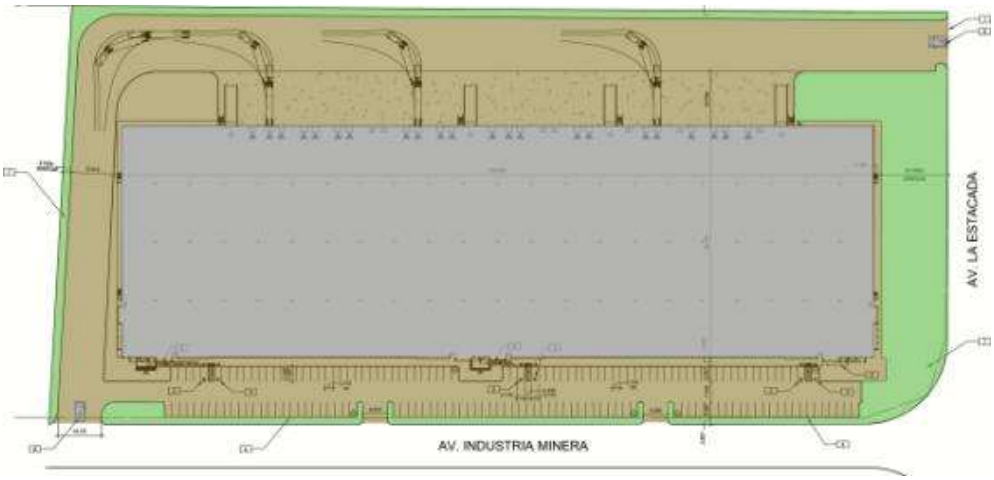

Figure 2: Vesta Inventory Building Zonning Diagram

Warehouse Footprint
Roads and Sidewalks
Green Areas

Materials and finishes of a modular design were used during construction of Vesta Inventory III Building. Exterior walls consist of tilt-up precast concrete panels; roofing is made of metal panels KR-18 with R-19 batt insulation; steel was used for structural purposes; 6mm glass with reflectasol treatment and aluminum framing was used for windows; the warehouse's interior flooring is made of 6" concrete, and exterior roads are made of impermeable asphalt pavement.

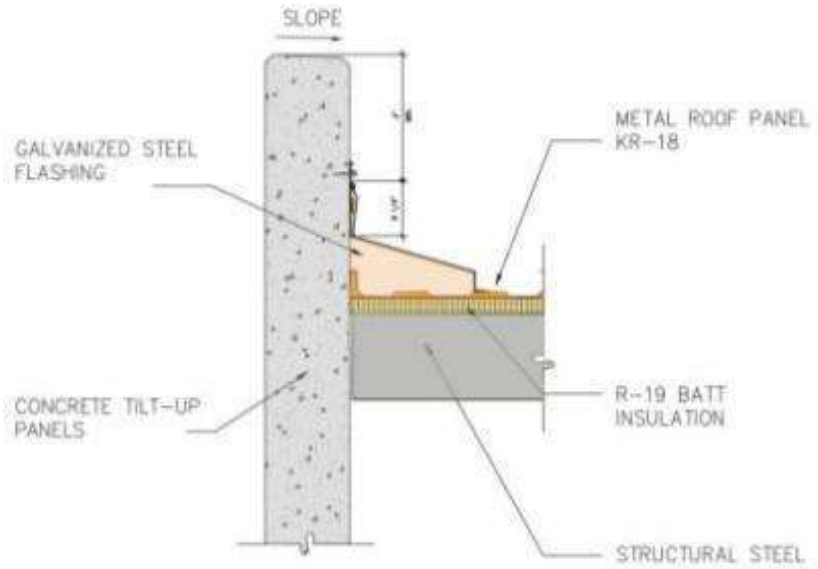

Figure 3: Vesta Inventory Building III materials and finishes

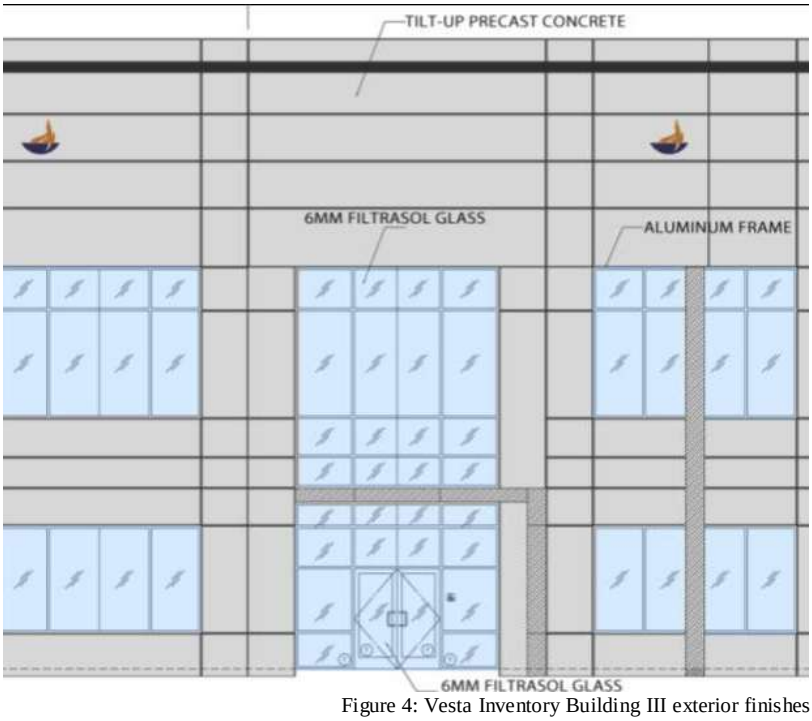

Figure 4: Vesta Inventory Building III exterior finishes

The following figures illustrate a typical industrial property from VESTA.

Figure 5: Vesta's warehouse images

VESTA is in charge of providing and installing water, sewer, power, telephone lines, fire protection and gas in each industrial property. Once the warehouses are leased, tenants are responsible for utilities and services on each property.

An analysis of the information provided by the client led to a preliminary identification of opportunity areas for the incorporation of sustainable strategies and best practices. The identified areas of opportunity are:

- *Use of appropriate insulation in the building envelope, to maximize thermal comfort while minimizing energy consumption. The insulation proposal will take into consideration three proposed locations for VESTA's Industrial Parks.*
- *Use of materials with a high Solar Reflectance Index to reduce energy consumption and heat island effect.*
- *Development of strategies for selection of materials and finishes based on LEED for Core & Shell principles.*
- *Development of a commissioning plan to verify that equipment and systems perform according to design.*
- *Use of efficient lighting and renewable energy systems to reduce energy consumption.*
- *Increase water catchment areas and pervious surfaces to minimize stormwater runoff.*
- *Use water efficient landscape to reduce water consumption for irrigation.*
- *Development of a recycling plan to reduce waste stream.*
- *Provide bicycle racks and/or storage to reduce automobile use and air pollution.*

142 Introduction to LEED® Core & Shell Rating System

LEED (Leadership in Energy and Environmental Design) Green Building Rating System™ is a voluntary, internationally renowned certification program developed by the US Green Building Council (USGBC) to create concrete standards for measurement of what constitutes a green building design, construction, and operation.

LEED rating system is used in as many as 115 countries around the world, it has over 9,800 certified buildings and over 51,000 buildings pursuing certification, making it the most widely used sustainable rating system, globally.

Among LEED rating systems, LEED for Core & Shell was developed to serve the speculative development market, in which project teams do not control all scopes of a building's design and construction. Core and Shell construction covers base building elements, such as the structure, envelope and building level systems.

The certification process in LEED Core & Shell is based on a hundredth point scale with option to ten extra points (for Innovation in Design and Regional Priority). The certification works by awarding points for concrete measures taken into five environmental categories: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials and Resources, and Indoor Environmental Quality.

Table 1: LEED Core & Shell categories

Category	Possible Points
Sustainable Sites	28
Water Efficiency	10
Energy and Atmosphere	37
Materials and Resources	13
Indoor Environmental Quality	12
Innovation in Design	6
Regional Priority	4
Total	**110**

The number of points the project earns determines the level of LEED Certification the project receives. LEED certification is available in four progressive levels according to the following scale:

- *Certified 40-49 points*
- *Silver 50-59 points*
- *Gold 60-79 points*
- *Platinum 80 points and above*

Sustainable Sites (SS): This category seeks to minimize buildings' impact on ecosystems and waterways, encourages regional landscape, and smart transportation choices. It seeks to reduce stormwater runoff, erosion, sedimentation, light pollution, heat island effect and construction related pollution.

Water Efficiency (WE): This category address issues related to building water usage. It encourages smart water use through water efficient fixtures, regional landscape, and innovative wastewater technologies.

Energy and Atmosphere (EA): Credits on this category address issues related to energy required during design, construction and operation of buildings. This category encourages commissioning of building energy equipment and systems, energy use monitoring, the use of efficient appliances, efficient lighting, and renewable and clean energy sources.

Materials and Resources (MR): This LEED category address issues related to materials selection, waste disposal, and waste stream reduction. It encourages the selection of sustainable grown, harvested, produced and transported products and materials. MR promotes the storage and collection of recyclables, material re-use, and source waste reduction.

Indoor Environmental Quality (IEQ): IEQ promotes strategies that improve indoor air quality, provide access to natural daylight and views. It address issues related to occupants' health, safety, and comfort; air change effectiveness; and air contaminant management.

Innovation in Design (ID): This category provides bonus points to projects that use constantly evolving processes, strategies, practices and technologies to improve a building's performance beyond LEED's credits requirements, or to account for green building considerations that are not specifically addressed elsewhere in LEED.

Regional Priority (RP): RP provides bonus points to those projects that address the most important local environmental concerns or priorities as determined by the USGBC regional chapters.

VESTA's Sustainable Handbooks (Industrial Parks & Building Shells) are based on the requirements for LEED™ Core & Shell 2009, as well as referenced standards mentioned in the LEED Reference Guide for Green Building Design and Construction, such as ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) or EPA (Environmental Protection Agency). The Sustainable Handbooks are based on LEED C&S to make sure the most up to date, internationally acknowledged sustainable principles and standards are being taken into consideration.

142.1 *Comparison between LEED, BREEAM and DGNB*

The DGNB (German Sustainable Building Certificate) was launched by the German Sustainable Building Council in cooperation with the German Federal Ministry of Transport, Building and Urban Development to evaluate sustainable buildings. This certification along with BREEAM (Building Research Establishment Environmental Assessment Method) developed in the United Kingdom, and LEED are the world most well-known sustainable buildings certification systems.

A comparison between these three certification systems was made to establish similarities, differences and set sustainability standards for the development of VESTA's Sustainable Construction Handbooks.

Main Sustainability Targets per Certification System (according to webites)		
LEED	BREEAM	DGNB
Lower operating cost and increase asset value of buildings Reduction of waste in the landfills Conservation of energy and water Design building which are safer and healthier for occupants Reduction of greenhouse effect Quality for tax discounts, zoning allowances, etc.	Decrease life cycle impacts of buildings. Recognition of environmental benefits of buildings. Provide credible environmental certification. Stimulate demand for sustainable buildings. Recognition of building with low environmental impact. Best practice in planning, design, construction and operation. Performance exceeding regulations requirements. Increase the market for innovative, cost effective solutions that minimize impact of building. Raise owners, occupants, designers and operators awareness. Progress towards corporate environmental objectives.	Nature conservation Retention of resources Lower impact on the climate Retention of economical capital Low maintenance and operational cost Human health concerns Protection of social and cultural values.

Table 2: Sustainability targets per system

Figure 6: Certification levels by system Source: DGNB German sustainable Building Council

The following table establishes a comparison between the three sustainable certification systems, based on the weight that is given to different topics. As shown in the table LEED and BREEAM certifications are more ecologically and socially oriented, while DGNB certification also grants great weight to the economical sustainability of the project.

Buildings and uses	DGNB	LEED	BREEAM
Ecological aspects	22.5%	64.0%	58.5%
Economic aspects	22.5%	0.0%	0.0%
Social aspects	16.0%	14.5%	14.0%
Functional aspects	6.5%	0.5%	5.0%
Technical aspects	22.5%	0.0%	5.0%
Aspects in planning processes	5.0%	2.0%	1.0%
Aspects in construction processes	3.0%	8.0%	7.0%
Aspects in operational processes	2.0%	1.5%	4.0%
Aspects of the building site	Separately evaluated	9.5%	5.5%

Legend

Proportion of elements considered in category >31%
Proportion of elements considered in category 11% <31%
Proportion of elements considered in category <10%
Category not considered

Table 3: Comparison between certification systems Source: Institute of Concrete Structures, TU Darmstadt

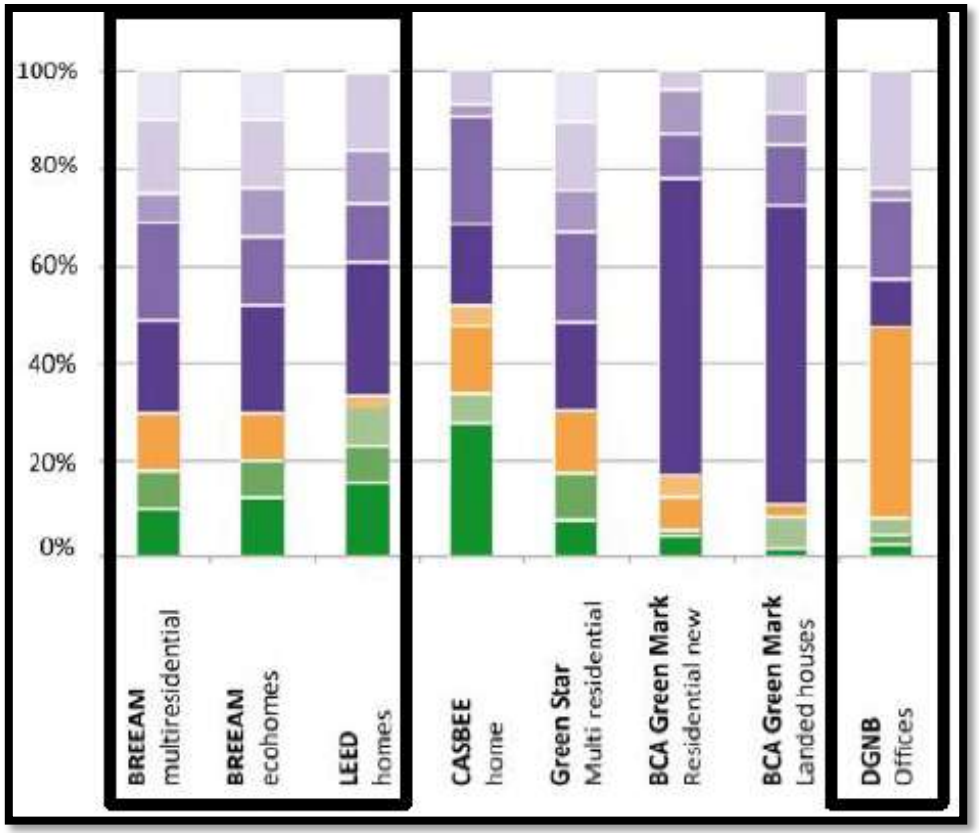

Figure 7: Comparison between certification systems

- Pollution, emissions
- Indoor environmental quality, wellbeing
- Water efficiency
- Materials & resources, waste & recycling
- Energy & atmosphere, renewable energy
- Awareness & education of user, function
- Maintenance & operation, economy
- Innovation & design, green features
- Location & linkages, transport
- Sustainable sites, land use & ecology

As can be seen on figure 8, according to a study developed by Drees & Sommer Advance Building Technologies for DGNB; DGNB and BREEAM have higher requirements than LEED, especially in topics related to economic sustainability of the project. DGNB emphasizes the importance of reducing maintenance and operation cost of the building, while the current version of LEED and BREEAM don't give too much weight to reducing life cycle cost of buildings. However, the operation cost of a project is directly related to its water and energy consumption, so it is indirectly addressed in the other certification systems.

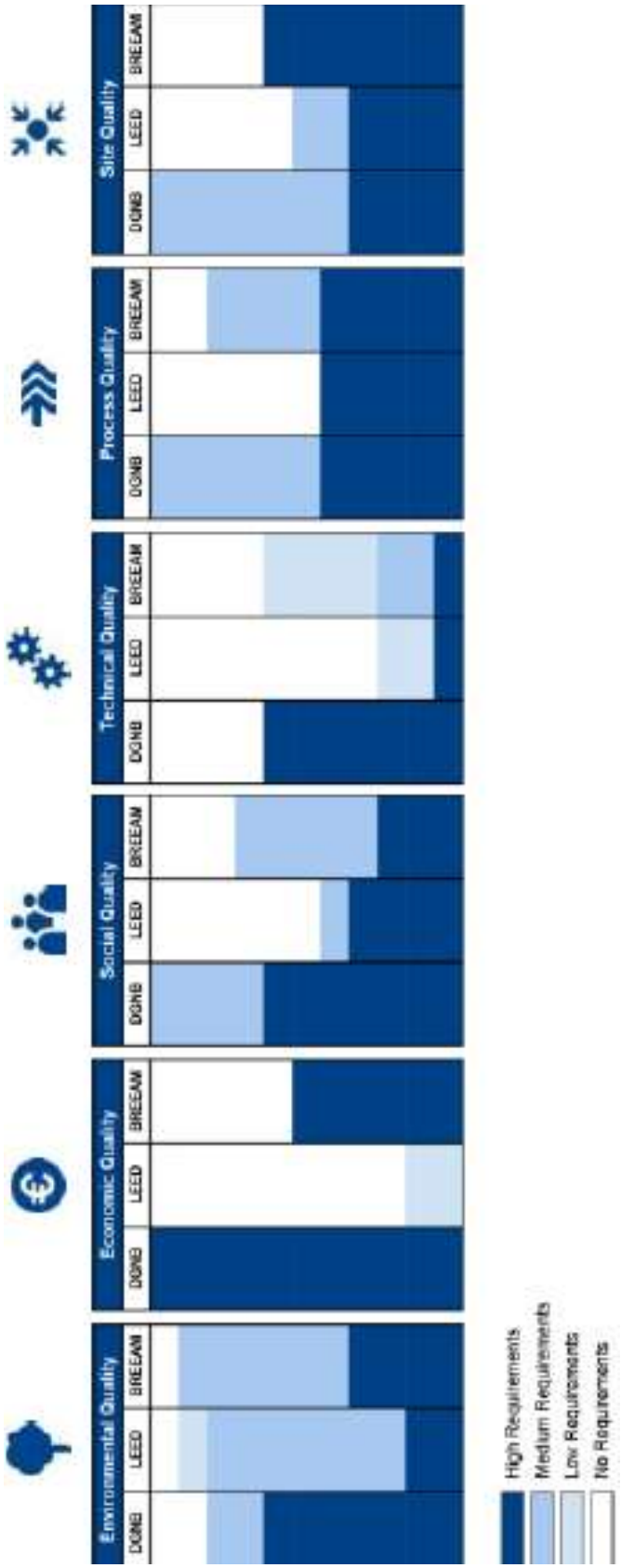

Figure 8: Requirements by difficulty for the three certificaton systems

150 Case Studies

There are a growing number of examples of sustainable buildings in Mexico and around the world. Three representative sustainable industrial buildings were chosen for the analysis of their sustainability features, strategies and characteristics. The analysis of these buildings was used as a reference of what is being done on the sustainable field and as a tool to look for new technologies and strategies that can be implemented in VESTA's industrial properties.

Amazon's Industrial Building in North Plainfield
Indianapolis, Indiana USA
LEED-CI Silver certified 2009

Figure 9: Amazon's North Plainfield Facility

This large Midwest distribution center for Amazon has been awarded LEED®-CI Silver Certification by the U.S. Green Building Council (USGBC). The industrial facility it is located in Plainfield in a master planned industrial park close to the Indianapolis International Airport.

An extensive amount of sustainability features were incorporated on this project. The lighting dims or shuts off lights when adequate daylight is available, an energy management system maintains minimum indoor air quality by monitoring outside air temperature and interior CO_2 concentration, efficient plumbing fixtures were used for water efficiency.

Key sustainable features:

- *Energy-efficient T5 fluorescent light fixtures, photoelectric cells and motion sensors.*
- *Reduction in lighting power by 35% below the standard through lighting dimming systems that works in accordance with daylight.*
- *High-efficiency, zero CFC-based refrigerant HVAC equipment.*
- *Installation of bicycle racks and changing/shower facilities to promote alternative, non polluting transportation mechanisms.*
- *Reduction in water usage by 20% with the use of low flow plumbing devices.*
- *Energy Management System (EMS) to regulate indoor air quality.*
- *Use of Energy Star equipment and appliances throughout the facility to reduce energy consumption.*
- *Paints, carpets, sealants, adhesives and other materials rated low in Volatile Organic Compounds (VOCs).*
- *Extensive recycling of construction waste.*
- *Diversion of 90% of the construction waste material from landfills and incinerators back to the manufacturing process.*
- *Use of construction materials where at least 20% is processed and manufactured within 500 miles of the site.*
- *Use of certified wood base products, complying with the Forest Stewardship Council's Principles and Criteria.*

Building 1 for Home Depot
Monroe, Ohio USA
LEED-NC Gold certified 2009
Size: 61,309 square meters

Figure 10: Building 1 for Home Depot

This project was developed as a built to suit distribution facility for Home Depot. The customer wanted to improve service and increase efficiency in the building while meeting stringent requirements, including a tight construction schedule and precise building specifications.

The building was noted for exemplary performance in its use of regional materials. Regional materials are materials and products that are extracted and manufactured within the region, supporting the use of indigenous resources and reducing environmental impacts resulting from transportation.

Among the sustainability goals pursued for the development of Park Corridor 75 Building 1 were water and energy use reduction. The building is designed to achieve 42 percent reduced water usage and 30 percent reduced energy consumption when compared to a standard building.

Key sustainable fixtures:

- *Low-flow plumbing fixtures to achieve a reduction of 42% in water use over a standard building.*
- *Paints, carpets, sealants, adhesives and other materials rated low in Volatile Organic Compounds (VOCs).*
- *Energy-efficient T5 fluorescent light fixtures, photoelectric cells and motion sensors.*
- *Dark-sky exterior lighting to minimize lighting pollution.*
- *Use of white TPO roof membrane. TPO membranes are single-ply roof membranes constructed from ethylene propylene rubber. They have been tested as having excellent resistance to ozone and algae, while being environmentally friendly and safe to install.*
- *Exemplary performance in its use of regional materials.*
- *Use of rainwater harvesting strategies.*
- *Use of native vegetation to reduce irrigation requirements.*
- *Optimum skylight design to reduce lighting requirements.*
- *Use of solar water heaters.*
- *Use of materials with a high recycled content.*
- *Use of permeable paving to reduce water runoff.*
- *Energy renewable systems.*

Figure 11: Acces to Building 1 for Home Depot

G.Park Blue Planet, Chatterley Valley
Staffordshire, United Kingdom
The World's first BREEAM Outstanding rated logistic building

Figure 12: G. Park Blue Planet, Chatterley Valley

This project, unique on its kind, was developed by Gazeley, a leading developer of sustainable distribution space. Since 1987, Gazeley has built over 5.6 million square meters of built to suit warehouses and distribution parks globally. Among its various customers are P&G, Nestlé, Asda/Wal-Mart, Morrisons, Volkswagen, John Lewis and third party providers such as DHL, CEVA, Geodis, TNT, Zufall and Norbert Dentressangle. Gazeley is renowned for its commitment to develop sustainable warehouses, improving its environmental performance and energy efficiency.

G. Park Blue Planet features a variety of renewable and sustainable power sources with capacity to support the park and export power and heat to the neighboring residential development. The buildings are designed to maximize daylighting, solar power generation, energy efficient lighting and to eliminate night-time light pollution.

The main warehouse drains rainwater collected from the roof into ponds, streams, green areas, and a 20,000 liters tank that stores the rainwater for flushing WCs. The south wall of the warehouse is designed as a solar attractor, to absorb the warmth of the sun, which is then fed into a plenum and redistributed throughout the building as free heating. The design of the warehouse achieves lighting and power savings of 49%, heating energy savings of 68% and water savings of 60% when compared to a conventional distribution building.

Figure 13: G. Park Blue Planet, Chatterley Valley interior and exterior details

Key sustainable fixtures:

- *Photovoltaics were integrated into ETFE rooflights (a completely recyclable material).*
- *An energy panel was used in the southern elevation, allowing naturally heated air to be captured and used for internal heating.*
- *Kinetic energy plates in the access road produce power when driven over by vehicles entering or leaving the site.*
- *Underfloor heating fuelled by on site Biomass power station.*
- *Energy efficient lighting linked to movement detectors and daylight saving controls.*
- *Rainwater harvesting for irrigation and toilets' flushing*
- *Maximization of prefabricated materials and recycling. Building materials were chosen for their longevity and end of life recycling.*
- *Maximization of materials supplied from within 35 miles (40%)*
- *Biomass micro power station that provides power and heat to the development.*

Lessons learned

The case studies indicate that sustainability strategies and measures are being taken predominantly in the following areas:

- *Use of natural daylight strategies and energy efficient lighting fixture to reduce energy consumption.*
- *Use of regionally produced and distributed materials.*
- *Use of materials and products with high recycled content.*
- *Use of native vegetation to reduce irrigation requirements.*
- *Rainwater harvesting.*
- *Natural ventilation.*
- *Renewable energy systems.*
- *Alternative transportation strategies to minimize single vehicle ridership.*

160 How to use this Handbook

This Handbook is intended for the use of architects, engineers, developers and professionals related to the building industry, that have previous experience and/or training in topics related to sustainable development.

The purpose of this Handbook is to provide a framework to incorporate sustainable construction best practices in VESTA's real estate properties. This Handbook is based on international sustainability standards and codes which have proven to be successful on similar scenarios. However, it is acknowledged that strategies suggested in this document are not the only ones that can achieve sustainability in a building.

This Handbook is intended to work along with VESTA's existing standards and policies. In case of conflict between a project and the information provided in this manual, further analysis should be done, and individual decisions should be taken. In any case, **the information provided in this document does not substitute existing owner's requirements, building codes and/or design regulations**.

This Handbook should be periodically updated, to maintain its currency, providing up to date sustainable strategies and best practices.

Trained personnel should be in charge of applying strategies and technologies included in this document, to ensure task are being performed in a satisfactory way. Measures taken towards implementing sustainability strategies should take into account installation guides, manuals and/or other documentation provided by the supplier, engineers and/or professional personnel involved.

200 GREEN BUILDING'S REQUIREMENTS

210 Owner's Project Requirements

It is fundamental that the owner documents the project's requirements through the *Owner's Project Requirements (OPR)* whenever a new construction or major renovation is being developed, to set the functional goals of the project in accordance to the owners needs. This document should be completed as early as possible, and should detail the functional requirements of the project and the expectations of the building's use and operation of systems (HVAC&R, lighting and daylight controls, domestic hot water systems and renewable energy systems if they are contemplated within the project).

The Owner's Project Requirements should document:

1. *Owner and User Requirements:* A description of the primary purpose, program, and use of the Project. It may also describe future expansion needs, flexibility, quality of materials, construction and operation cost goals.
2. *Environmental and Sustainability Goals:* A description of specific environmental or sustainability goals (like level of LEED certification desired).
3. *Energy Efficiency Goals:* A description of specific energy efficiency goals relative to local energy codes or internationally renowned standards. Desired energy efficiency measures that provide cost effective energy savings. Requirements for building orientation, landscaping, façade, fenestration, envelope and roof features that will affect energy use.
4. *Indoor Environmental Quality Requirements:* For each program/usage area it should include a description of: anticipated occupancy schedules, thermal comfort requirements, temperature and/or humidity requirements, desired user controllability of HVAC systems, ventilation and filtration requirements, accommodations for after hours use, acoustic environment requirements, indoor lighting requirements, occupant lighting control requirements, other owner's requirements like natural ventilation, operable windows, views.
5. *Equipment and Systems Expectations:* For each program/usage area it should include a description of: special HVAC equipment requirements such as type, quality, reliability, efficiency, preferred manufactures, maintenance requirements; special lighting requirements such as preferred lamp and ballast types; other systems requirements such as specific efficiency target, desired technologies, etc.
6. *Building Occupant and O&M Personnel Expectations:* A description of how the facility will be operated and by whom, including a description of the desired level of training and orientation required for the building occupants to understand and use the building systems.

Refer to Appendix 1 to see an outline of an Owner's Project Requirements document.

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300 GENERAL GUIDELINES FOR GREEN BUILDING'S DESIGN

This section aims to provide general guidelines for green building's design. The strategies and recommendations covered in this section have major implications in the development of sustainable industrial properties. It includes strategies like an adequate site selection, stormwater management, interior environmental quality, natural daylight strategies and strategies to procure thermal comfort for the building's users, which can greatly influence a building's environmental impact.

Because it is unknown the exact location and design requirements of VESTA's future industrial shells, it is not possible to provide specific recommendations about how to address the selected site. However, this section provides general criteria about how to select and develop a sustainable site, and it should be taken into consideration during those early phases of the project.

This Handbook does not pretend to substitute judgment and/or professional criteria of the people involved in the development of the project. It is a duty of the owner and/or developer to ensure that proper methods and strategies are being used for the project.

310 Sustainable Sites

"The selection and development of a building's site are fundamental components of sustainable practices. Environmental damage caused by construction may take years of work to remedy" (LEED Green Building Design and Construction, 2009).

It is fundamental to select a site that does not compromise existing habitats. A site that takes into account emissions associated with transportation of building's occupants. Moreover, the development of the chosen property must use sustainable practices to decrease soil erosion, sedimentation and pollution of the environment.

A properly developed site can reduce the heat island effect, can minimize stormwater runoff, can contribute to restore wildlife habitat and decrease pollution, while reducing energy, water consumption and maintenance cost of the building.

A sustainable site design requires holistic, ecologically based strategies to create and built projects that do not alter or impair, but instead help repair and restore existing site ecosystems, to promote sustainable development and well being of its occupants.

It is important to keep in mind sustainable sites strategies during the selection and development of the project. The architect, the owner and other team member involved should try to implement the strategies and recommendations covered in this section.

311 Site Selection

Sustainable buildings start with proper site selection. The location of a building will have effects on many factors like security, accessibility, energy consumption, energy consumed for transportation, ecosystems, the use/reuse of existing structures and infrastructures, etc. It is important to address site selection early in the project development process to ensure these factors are considered. Equally important is that the people involved in site selection understand sustainable site design and the impact a building's location can have on its performance.

Development of industrial properties should be avoided on sites that meet any of the following criteria:

- *Prime farmland*
- *Sites whose elevation is lower than 1.5meters above the elevation of the hundredth year flood*
- *Land identified as habitat for any species on federal or state threatened or endangered lists.*
- *Land within 30 meters of wetlands and 15 meters of a water body.*
- *Land that prior to acquisition for the project was public parkland.*

Figure 14: Characteristics to consider during site selection

Don't develop on land next to waterbodies

Brownfield redevelopment

Don't develop on farmland

Develop on dense sites

312 Development Density and Community Connectivity

During the site selection phase, the owner, architect and developer should give preference to sites within an existing urban fabric. Choosing a previously developed site contribute to take advantage of existing infrastructure while preserving natural habitat.

Development density and community connectivity promotes the use of public transportation in lieu of automobiles, increases community connectivity, decreases infrastructure needs, and provides access to amenities for populations dependent on public transportation.

This strategy addresses two basic issues: density of the surrounding neighborhood and occupant access to everyday services. During site selection priority should be given to:

- *Previously developed sites with a minimum density of 13,777square meters per hectare.*
- *Previously developed sites within .80 kilometers of a residential area with a minimum density of 25 units per hectare and accessibility to at least 10 basic services.*

  Basic services include but are not limited to: Banks, place of worship, convenience grocery, day care, cleaners, fire station, beauty, hardware, laundry, library, medical/dental center, senior care, park, pharmacy, post office, restaurants, schools, supermarket, theater, community center, fitness center, and museums.

Figure 15: Development density and community connectivity

Priority should be given to previously developed sites with a minimum density of 13,777 square meter per hectare

Priority should be given to sites with accesibility to services and existing infrastructure

313 Alternative Transportation – Public Transportation Access

Public transportation provides people with mobility and access to employment, community resources, medical care, and recreational opportunities. The incorporation of public transportation options can help a community expand business opportunities, reduce sprawl, and create a sense of community. Moreover public transportation helps to reduce road congestion and travel times, air pollution, energy and oil consumption, benefiting both riders and non-riders.

Public Transportation Access

The project should aim to be located within 400 meters walking distance (measured from a main building entrance) of one or more stops for two or more public or private bus lines usable by building occupants. In case the industrial building shell does not comply with this condition, public transportation access should be procured to the nearest population center.

Alternative Transportation

Incentives should be granted to people using public and/or alternative transportation (low emitting vehicles, bicycles, carpooling, etc.) in order to encourage its use among building's occupants. An analysis of occupant's transportation necessities and preferences should be done to determine the most viable transportation options.

Some strategies to promote alternative transportation are:

- *Provide preferred parking for low emitting, fuel efficient, carpool and vanpool vehicles equal to 5% of the total vehicle parking capacity. Preferred parking is considered as those parking spaces closer to the building entrance and/or covered parking closer to the building entrance.*
- *Size parking capacity to meet but not exceed minimum local zoning requirements.*
- *For projects with an area of 27,870 square meters of less: provide secure bicycle racks within 180 meters of the building entrance for 3% or more of all building users.*
- *For projects larger than 27,870 square meters: provide secure bicycle racks within 180 meters of the building entrance for 3% of the occupants for up to 27,870 square feet, then an additional 0.5% for the occupants of the space over 27,870 square meters.*

Strategies to promote alternative transportation:

Figure 16: Strategies to increase alternative transportation in the facilities

314 Maximize Open Space

Open space provides habitat for vegetation and wildlife, contributes to reduce the urban heat island effect, increases stormwater infiltration, and provides the human population on the site with a connection to the outdoors.

The design team should try to minimize the development footprint and/or provide vegetated open space within the project boundary such that the amount of open space exceeds local zoning requirements by 25%, or should provide vegetated open spaces equal to 20% of the project's site area.

Strategies like using open grid pavement and green roofs can count towards open space area.

Protect or Restore Habitat

An increase in open space area promotes biodiversity, by conserving existing natural areas, or by restoring areas within the site for vegetation and wildlife.

- *Previously developed sites should protect or restore a minimum of 50% of the site (excluding the building footprint) or 20% of the total site area, whichever is greater, with native or adapted vegetation.*
- *In case the previous strategy is not achievable, site disturbance should be limited to:*
    - *40 feet beyond the building perimeter.*
    - *10 feet beyond hardscape.*
    - *15 feet beyond primary roadway curbs and main utility branch trenches.*
    - *25 feet beyond constructed areas with permeable surfaces.*

Figure 17: Strategies to reduce site disturbance

Heat Island Effect

The heat island effect is a phenomenon in which built up urban areas are hotter than surrounding rural areas. The annual mean air temperature of a city with one million people or more can be up to 12°C warmer than its surrounding.

Natural surfaces are often composed of vegetation and moisture-trapping soils; they use a relatively large proportion of the absorbed radiation in the evapotranspiration process and release water vapor that contributes to cool the air in their vicinity. In contrast, built up surfaces are composed of a high percentage of non-reflective and water-resistant construction materials. As a consequence, they absorb a significant proportion of the incident radiation, which is released as heat.

Elevated temperature from urban heat islands can affect a community's environment and quality of life, increasing energy demand, air conditioning costs, air pollution, greenhouse gas emissions and water quality.

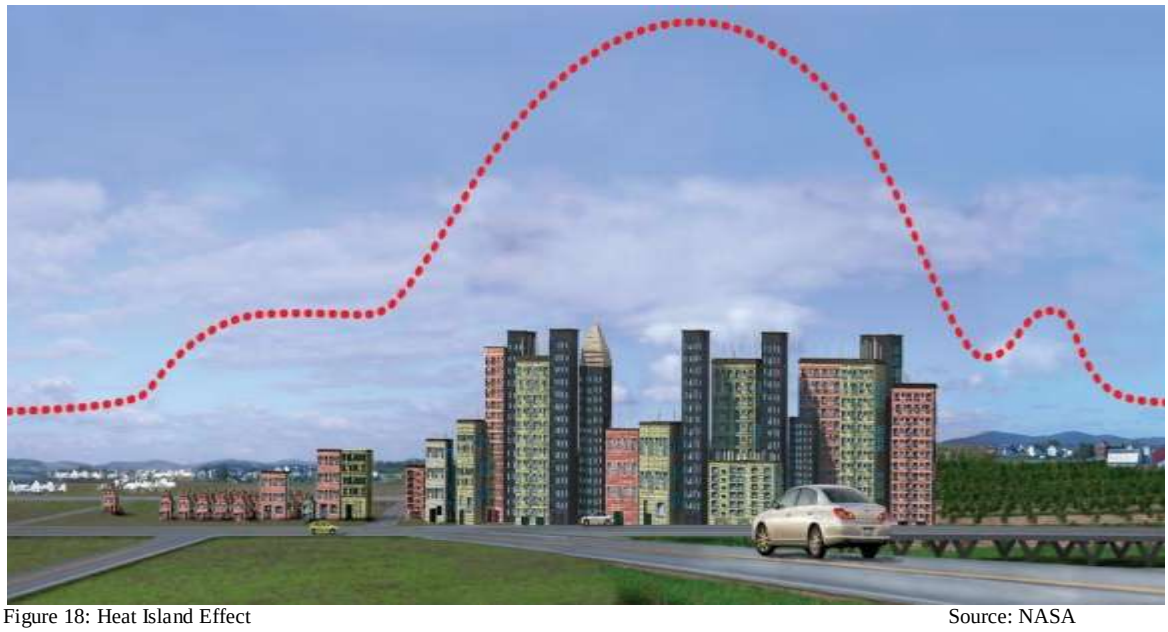

Figure 18: Heat Island Effect Source: NASA

The project should aim to reduce heat islands to minimize impacts on microclimates, human and wildlife habitats. To minimize heat islands roofing and hardscape materials should be carefully chosen.

Roofing Materials

Green roofs, photovoltaic panels, and/or materials with a high solar reflectance index should be used in at least 75% of the roof to minimize the heat island effect. See section 431.4 for more details about roofing materials.

Figure 19: Roofing materials that contibue to heat island effect reduction

Hardscape Materials

Use trees, structures covered by solar panels, materials with a solar reflectance index of at least 29, and/or open grid pavement for at least 50% of the site hardscape to reduce heat island effect.

Figure 20: Hardscape materials that contribute to heat island effect reduction

315 Stormwater Management

An effort to limit disruption of natural hydrology should be made. This can be achieved by reducing impervious cover and increase on-site infiltration. Applying these strategies will contribute to reduce or eliminate soil erosion, reduce potable water consumption, maintain the natural aquifer recharge cycle and restore depleted stream base flows. Strategies for both stormwater quantity and quality control should be implemented for better results.

Stormwater Quantity Control

One of the following requirements should be met:

- *Implement a stormwater management plan that prevents the postdevelopment peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the one and two year 24 hour design storms.*
- *Implement a stormwater management plan that results in a 25% decrease in the volume of stromwater runoff from the two year 24 hour design storm.*

Stormwater Quality Control

Pollution of natural water flows should be prevented, during construction and operation of the industrial facilities. Stormwater management practices should be implemented to treat polluted water before it leaves the site. It is advisable to treat or infiltrate 90% of the average annual rainfall.

Stormwater Management Plan

The first thing that should be taken into account for the development of a management plan, that contributes to maintain or improve stormwater quality and quantity control, is the prevailing condition of the site. The stormwater management plan should try to preserve existing water flow and natural soil conditions. On previously developed sites, the purpose of the stormwater management plan is to reduce existing water flow or restore natural site conditions. The following strategies are useful to reduce and treat water flow.

- *Reduce impermeable surfaces.* Pervious surfaces allow water to percolate into the soil to filter out pollutants and recharge the water table, reducing stromwater runoff. Impervious surfaces should be limited to vehicular roads.
- *Use pervious materials*. Preference should be given to pervious materials, open grid pavement, permeable pavers, etc. The selected material will depend on the specific requirements off each area.

Figure 21: Commonly pervious materials for sidewalks and roads

- *Design taking into account the topography of site*. The building and landscape areas should be design in accordance to the natural conditions of the site, to minimize erosion and site disturbance.

- *Use retention pounds to control water runoff*. Retention basins can be use to capture and infiltrate water coming from paved areas and impervious surfaces. It is advisable to direct water runoff towards retention basins to promote its infiltration before it leaves the site.

Figure 22: Stormwater management - retention pound (Source: Centro de aguas urbanas)

- *Use vegetated areas to control water runoff*. Vegetated areas can be placed between paved areas to reduce stormwater runoff and promote infiltration.

Vegetated filter strips have a range of total suspended solids removal between 40%-90% depending on the slope, soil, and size.

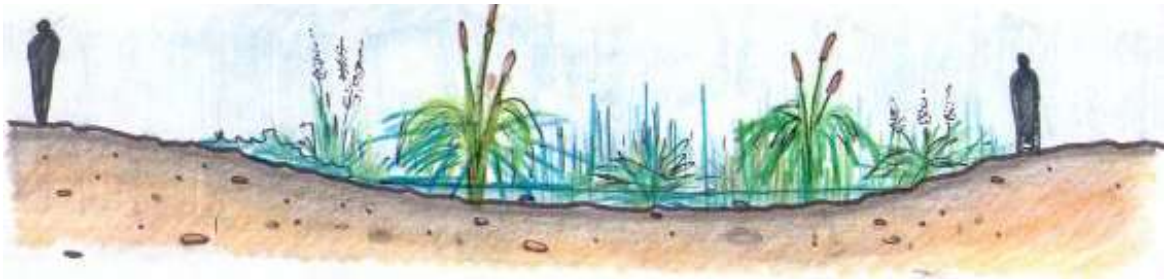

Figure 23: Stormwater management - vegetated areas (Source: Centro de aguas urbanas)

- *Green roofs.* Greening of rooftops, by incorporating plants into the design of roofing systems contribute to reduce the impacts of stormwater runoff. The benefits of green roofs for stormwater control include direct retention of a portion of the rainfall, and delaying and decreasing the peak rate of runoff from the site. Moreover, green roof have a range of total suspended solids removal between 75%-90%, depending on the system and vegetation used. See section 431.42 for more details about green roof systems.

- *Cluster development to reduce paved surfaces such as roads and sidewalks.*

320 Indoor Environmental Quality

Indoor Environmental Quality (IEQ) refers to all environmental factors that affect the health and wellbeing of building occupants. IEQ encompasses factors such as indoor air quality, airborne contaminants, comfort, humidity, air exchange, acoustics, and lighting quality.

The main purpose of IEQ is to maintain and improve standards of health and comfort within indoor environments. By improving indoor air quality building related illnesses can be prevented, absenteeism can be reduced and employee productivity can be improved.

Providing acceptable indoor air quality for occupants and workers during and after construction requires significant planning and understanding of potential issues. The strategies to provide an adequate IEQ within buildings will vary depending on the specific design of warehouses and office buildings within VESTA's industrial parks. This chapter covers basic strategies and recommendations to achieve an adequate IEQ, and should be taken in consideration during the design phase.

321 Environmental Tobacco Smoke (ETS) Control

Smoking inside the building and within eight meters of entries, outdoor air intakes and operable windows should be prohibited, in order to prevent or minimize exposure of building occupants, indoor surfaces and ventilation air distribution systems to environmental tobacco smoke.

Figure 24: Designate smoking areas for tobacco smoke control

322 Indoor Chemical and Pollutant Source Control

The exposure of building occupants to potentially hazardous pollutants should be minimized by implementing these indoor chemical and pollutant control measures:

- *Install permanent entryway track-off systems*
- *Exhaust spaces with hazardous gases or chemical directly to the outdoors*
- *Provide containment drains to control hazardous liquids wherever they are used*
- *Install minimum MERV 13 rated filters on all mechanical ventilation systems*

Figure 25: Entryway track-off systems

323 Daylight

Daylight in buildings is important for its quality, spectral composition, and variability. It provides high luminance and permits excellent color rendering. Working long-term in electric lighting is believed to be detrimental to health, while working by daylight is believed to result in less stress and discomfort.

However, daylight can produce uncomfortable solar glare and very high luminance reflections on display screens, both of which interfere with good vision. Daylight can also increase energy consumption. Since glass is a poor insulator, a big amount of heat is loss and gain through windows and skylights. These factors need to be taken into consideration during the design phase of VESTA's buildings. This section provides general recommendations for an adequate daylight design, which should address:

- *Building orientation and shape*
- *Heat loss and gain through glazing*
- *Solar glare*
- *Direct solar heat gain during summer months*
- *Daylight sensors with dimming to increase energy saving*

Building orientation and shape

Building shape and orientation should be considered since the beginning of the project. These factors should be acknowledged during the design phase to be able to provide daylight in an efficient way.

- *North and south façade exposure should be maximized for daylighting harvesting. Whenever possible openings to east and west should be avoided.*

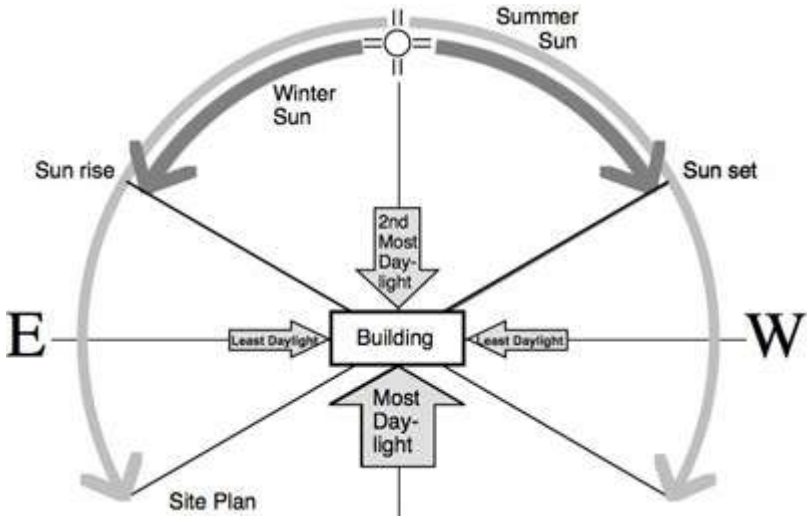

Figure 26: Building orientation and daylight (Source:WBDG)

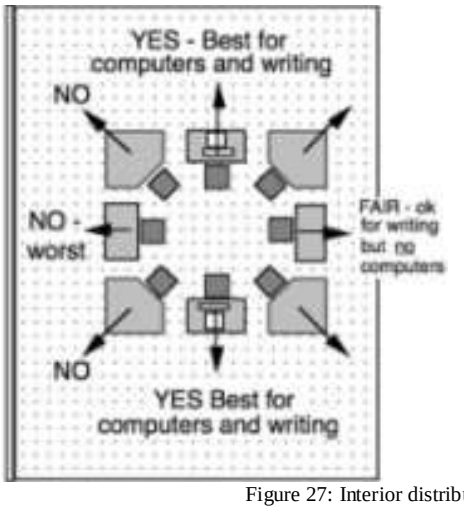

Figure 27: Interior distribution and daylight (Source: WBDG)

- *On the south façade overhangs and other solar shading devices should be proposed to reduce direct solar heat gain.*

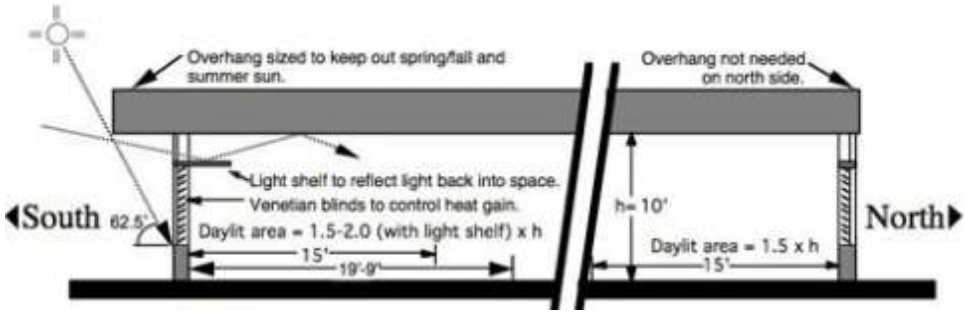

Figure 28: Overhangs (Source: WBDG)

- *Rectangular buildings with a greater north-south exposure are advisable since they allow natural daylight in all building's areas.*

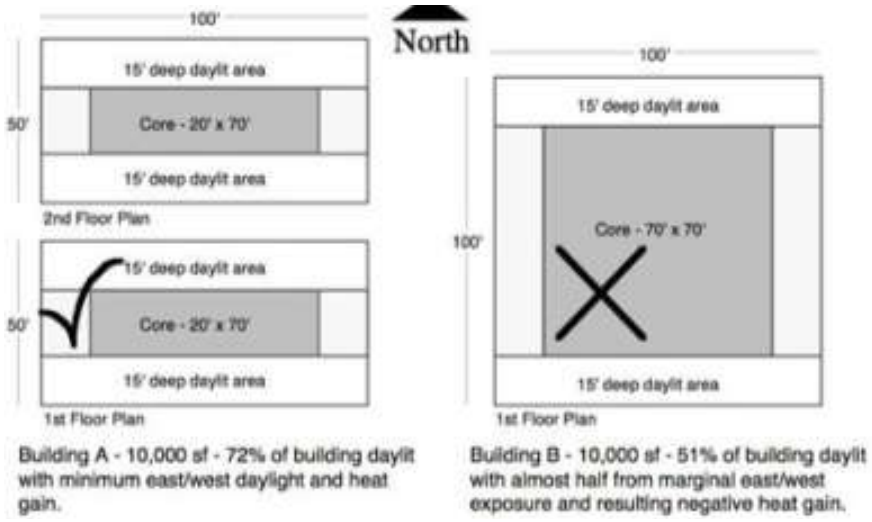

Figure 29: Daylight and building shape (Source: WBDG)

Strategies to improve natural daylighting in the building

Daylight can be achieved through the use of windows and/or skylights. The following information should be taken into consideration during the design phase to improve daylight quality.

As a general rule, daylighting will only reach a distance of 2.5 times the height of the top of the window above the work plane. In a standard office building with a window height of 2.5m, this means a maximum of about 5-7meters.

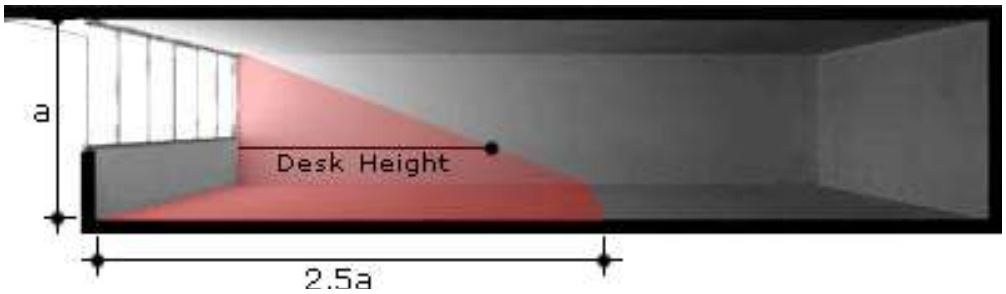

Figure 30: Daylight in interior spaces (Source: ECOTECT Community)

To improve daylighting within a building, windows can be added on multiple sides of the room, or a distribution system such as a lightshelf or prismatic glazing can be used to direct some of the light up onto the ceiling where it will diffuse deeper into the space.

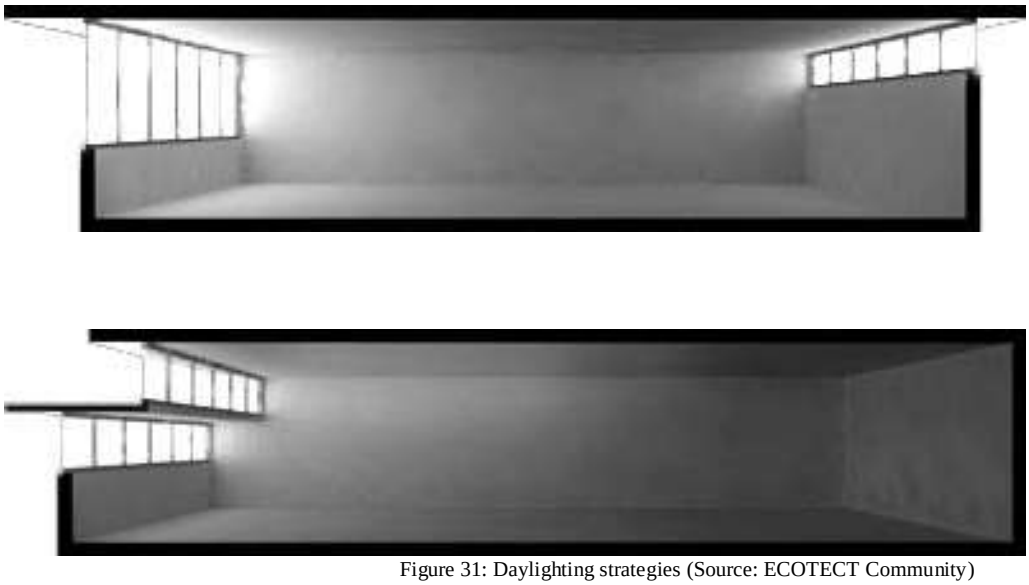

Figure 31: Daylighting strategies (Source: ECOTECT Community)

Skylights are openings cut through the roof of a building, though they give excellent daylight levels it is difficult to control solar radiation coming from these elements. Angled louvres or some other form of seasonally adjustable shading must therefore be used, especially in hot climates.

Figure 32: Daylight strategy – Skylights (Source: ECOTECT Community)

Saw-tooth apertures are formed from a vertical glass element and a sloping roof. Saw-tooth glazing facing away from the equator provides diffuse daylight from the sky without direct sun penetration. Saw-tooth glazing facing East or West is very difficult to protect, so it should be avoided.

Figure 33: Daylight strategy – Saw-tooth apertures (Source: ECOTECT Community)

A monitor aperture has two opposing vertical glazed elements raised above the general roof line. Daylighting provided by these openings is similar to the one provided by saw-tooth apertures

Figure 34: Daylight strategy – Monitor aperture (Source: ECOTECT Community)

The atrium is a core lighting technique where the center of the building is opened up with a glazed element at the top. The outside perimeter is lit with windows while the interior spaces receive diffuse light from the atrium. The ratio of height to width of the light well should not be greater than 2:1.

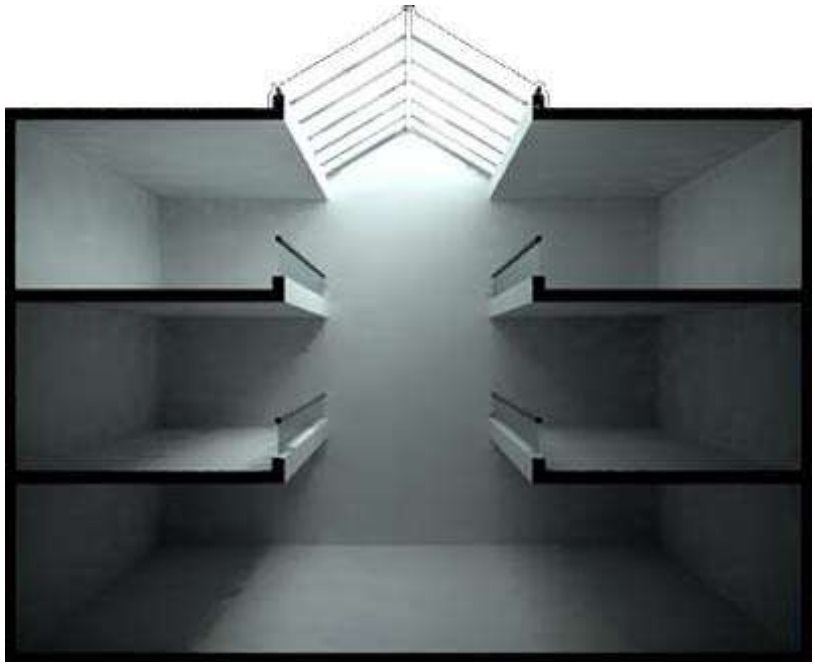

Figure 35: Daylight strategy – atrium (Source: ECOTECT Community)

Light wells down each side of an atrium can significantly increase the natural lighting, providing usually inaccessible spaces with a sense of connection with the outside.

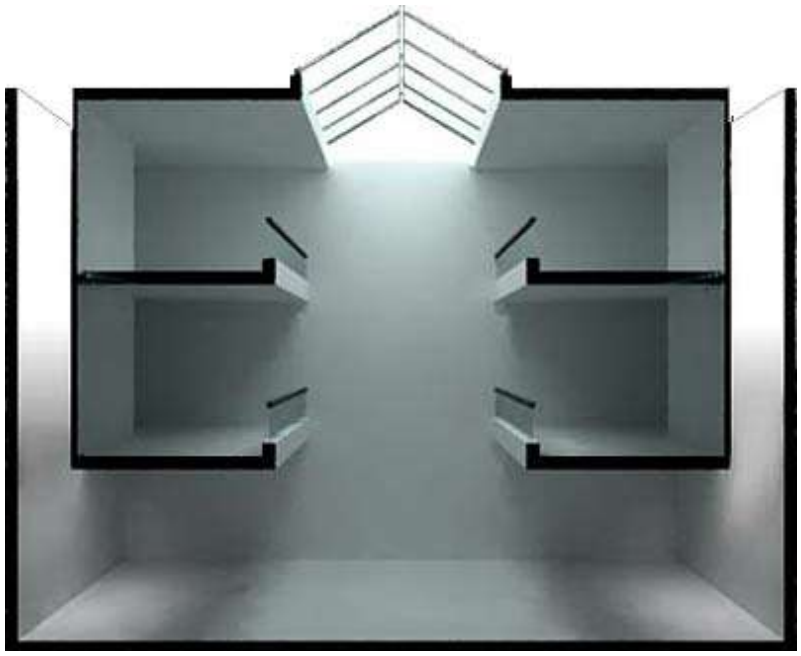

Figure 36: Daylight strategy – light well (Source: ECOTECT Community)

324 **Views**

Buildings that provide views to the outdoors have proven to enhance productivity, and overall occupant comfort and well-being. Recent studies have linked having access to views of nature in the workplace to the relief of boredom, anxiety, and stress.

Offices and other permanently occupied constructions within VESTA's industrial parks should try to provide a direct line of sight to the outdoors for occupants in 90% of all regularly occupied areas. Some strategies to increase views accessibility are:

- *Consider footprint shape and space layout early in design to maximize views to glazing.*
- *Design the building so that as many regularly occupied spaces as possible are located near the perimeter, with access to glazing. Open offices should be located at the perimeter with enclosed spaces and support areas near the building core.*
- *Glazing should be shaded appropriately to control solar heat gains.*
- *Include interior transom glazing to add views to enclosed spaces away from the perimeter of the building.*

Figure 37: IncreasIncreased views accessibility

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400 TECHNICAL STANDARDS

410 General Criteria

The following section provides general criteria for the selection of sustainable materials and finishes, and should be taken in consideration during the design and construction phase of the project. Specific details about constructive elements and environmentally friendly finishes for VESTA's warehouses can be found on section (432).

411 Materials and Resources

411.1 *Selection Criteria*

There are significant environmental impacts associated with materials used in a construction, like pollutants release, habitat destruction, and depletion of natural resources. The use of durable, healthy and environmentally responsible materials in a building contributes to preserve natural resources and wellbeing of its occupants.

The selection of environmentally responsible materials requires the development of criteria to evaluate and properly choose building materials. The following is a recommended selection criterion for building's materials:

- *Use materials that are nontoxic or demonstrate to have reduced toxicity.*
- *Use products that have minimal chemical emissions, emit low or non volatile compounds (VOCs), and avoid the use of chlorofluorocarbons (CFCs).*
- *Use products with identifiable recycled content including pre-consumer and post-consumer.*
- *Use materials that are durable, reusable and/or recyclable.*
- *Use products manufactured with resource efficient processes including reduced energy consumption, minimal waste production, and reduced green house production.*
- *Use locally extracted, harvested and manufactured materials, to reduce energy consumption and resources required for transportation.*
- *Use rapidly renewable materials, harvested from sustainably managed sources, and preferably with independent certification.*

411.11 *Regional Materials*

The use of regional materials reduces fuel consumption and greenhouse gas emissions from the transportation of materials to the construction site. Regional materials require less protective packaging, and they are thereby associated with less waste.

Regional materials are easier to track down and determine if the extraction and processing were carried out in an environmentally responsible manner. The incorporation of regional materials has cultural and economic benefits at the local level; it can provide residents with a sense of identity, place and history, meanwhile supporting the local economy.

No less than 10 percent of products and materials used in the construction should be regionally extracted (within an 800 kilometers radius), harvested or recovered, and manufactured. The percentage is based on cost of the total materials value.

The following figures illustrate the regional material radius for three selected locations of VESTA's industrial shells. These locations were chosen because they are representative of the different climatic and zoning conditions of VESTA's real estate properties.

Figure 38: Distribution of selected Vesta's Industrial Properties (Source: vesta.com.mx)

Tijuana:

The 800 kilometers radius for Vesta Park in Tijuana (El Potrero Vesta Park) can be seen on figure 39; it includes part of the states of California, Nevada, Utah, Arizona, and a small part of New Mexico in the northern country of USA. In Mexico it includes the states of Baja California Norte, Baja California Sur, Sonora, and a small portion of Chihuahua.

Figure 39: Regional material radius for El Potrero Vesta Park in Tijuana

Queretaro:

The 800 kilometers radius considered for regional materials, considering the Bernardo Quintana Industrial Park in Queretaro (Figure 40) includes a small part of Texas, the north east part of Mexico (Nuevo Leon, Tamaulipas, and Coahuila), all the central states of the country (Mexico City, San Luis Potosi, Guadalajara, etc.), and part of the southern states of Mexico (Guerrero, Oaxaca, part of Tabasco and Chiapas).

Figure 40: Regional material radius for Bernardo Quintana Industrial Park in Queretaro

Cancun:

The regional priority radius for Vesta Industrial Properties in Cancun (figure 41) includes part of Central America (Guatemala, Belize, Honduras, and a small part of San Salvador), the west part of Cuba, a reduced portion of Florida, and part of the south of Mexico (Quintana Roo, Yucatan, Campeche, Tabasco and Chiapas).

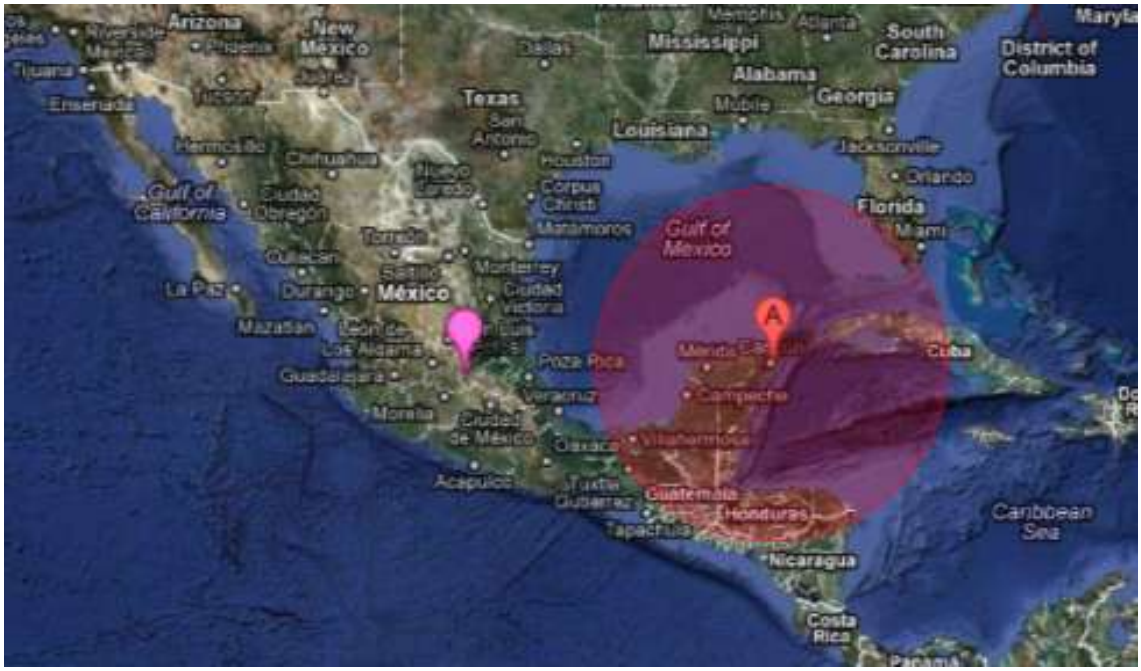


Figure 41: Regional material radius for Cancun, Cancún

411.12 ***Recycled Content***

A recycled content product is an item made with materials that were recycled, diverting them from conventional disposal methods such as landfills or incinerators.

Buying products with recycled content has many environmental benefits, among the benefits of using recycled products are:

- *Recycled products help to divert waste from landfills.*
- *They contribute to conserve natural resources, energy, and wildlife.*
- *The manufacturing process for recycled products creates far more jobs than disposing materials in landfills or incinerators.*
- *Recycled products from locally sourced materials/ waste reduce transportation requirements.*
- *Buying recycled products contribute to a more sustainable future by ensuring that the materials collected will be used again to manufacture new products or materials.*
- *Choosing recycled products increases environmental awareness.*

At least ten percent of materials and products used for construction should be recycled or should incorporate recycled content materials. The recycled content of a material is determined by weight. The recycled fraction of the assembly is then multiplied by the cost of the assembly to determine the recycled content value. Mechanical, electrical and plumbing components are not included in the calculations.

It is advisable to give preference to materials with post-consumer recycled content. Post consumer recycled materials are products that have completed its life cycle as a consumer item and would otherwise have been disposed of as solid waste. Pre-consumer or post-industrial recycled content refers to scrap that is generated during the manufacturing process and its recycled back into its raw material state.

Figure 42: Recycled content verification seal

411.13 *Certified Wood*

Certified wood come from responsibly managed forest. The objective of certification is the improvement and documentation of forest management practices. It is usually associated with eco-labeling and chain of custody certification.

The basic requirements for forest certification programs usually include:

- *Protection of biodiversity, species at risk and wildlife habitats.*
- *Sustainable harvest levels.*
- *Protection of water quality.*
- *Third-party certification audits performed by accredited certification bodies.*
- *Publicly available certification audit summaries.*
- *Complaints and appeals processes.*

The Forest Stewardship Council (FSC) is the world's foremost and internationally recognized forest certification. The FSC certification is a voluntary tool that supports responsible forest management worldwide, ensuring that products certified under the FSC label are from responsibly harvested and verified sources.

Figure 43: Certified Wood Seal (Source: fsc.org)

At least 50 percent of wood-based materials and products used in a building should be certified in accordance with FSC's principles and criteria, including framing, flooring, doors and finishes. Only materials and products installed permanently in the project should be considered.

411.2 *Low-Emitting Materials*

Low-emitting materials are products that contain zero or low-volatile organic compounds (VOCs), reducing significantly the release of pollutants into the indoor environment.

VOCs are chemicals that are emitted by solids and liquids that evaporate into air at room temperature. Elevated levels of VOCs and interior pollutants have been linked to health concerns such as eye, nose and throat irritation, headaches, loss of coordination, nausea, and other health problems.

An increased awareness of possible health risks and air quality concerns has led to a demand for products lower in VOCs, which are now widely available. What is considered a low concentration of VOC emissions will vary according to the product type. The following sections provide further recommendations for the selection of low emitting materials of commonly used products.

411.21 ***Adhesives and Sealants***

All adhesives and sealants used on interiors shall comply with the VOC limits established on the table below.

Architectural Applications	**VOC Limit (g/L less water)**
Indoor Carpet Adhesives	50
Carpet Pad Adhesives	50
Wood Flooring Adhesives	100
Rubber Floor Adhesives	60
Subfloor Adhesives	50
Ceramic Tile Adhesives	65
VCT & Asphalt Adhesives	50
Drywall & Panel Adhesives	50
Cove Base Adhesives	50
Multipurpose Construction Adhesives	70
Structural Glazing Adhesives	100
Specialty Applications	**VOC Limit (g/L less water)**
PVC Welding	510
CPVC Welding	490
ABS Welding	325
Plastic Cement Welding	250
Adhesive Primer for Plastic	550
Contact Adhesive	80
Special Purpose Contact Adhesive	250
Structural Wood Member Adhesive	140
Sheet Applied Rubber Lining Operations	850
Top & Trim Adhesive	250
Substrate Specific Applications	**VOC Limit (g/L less water)**
Metal to Metal	30
Plastic Foams	50
Porous Material (except wood)	50
Wood	30
Fiberglass	80
Sealants	**VOC Limit (g/L less water)**
Architectural	250
Nonmembrane Roof	300
Roadway	250
Single-Ply Roof Membrane	450
Other	420
Sealant Primers	**VOC Limit (g/L less water)**
Architectural Non Porous	250
Architectural Porous	775
Other	750

Table 4: Adhesives and Sealants VOCs limits (Source: LEED, 2009)

Aerosol Adhesives must comply with the VOC limits listed below.

Aerosol Adhesives	VOC Limit
General purpose mist spray	65% VOCs by weight
General purpose web spray	55% VOCs by weight
Special purpose aerosol adhesives (all types)	70% VOCs by weight

Table 5: Aerosol Adhesives VOC limits (Source: LEED, 2009)

411.22 ***Paints and Coatings***

Paints and coatings used on interiors shall comply with the VOC limits listed on table 6.

Coating	Ceiling Limit (g/L less water)	Current Limit (g/L less water)
Bond breakers	350	
Clear wood finishes	350	
- Varnish	350	
- Sanding	350	
Sealers	680	550
- Lacquer		
Clear brushing lacquer	680	
Concrete-curing compounds	350	
Concrete-curing compounds for roadways and bridges	350	
Dry-fog coatings	400	
Fire-proofing exterior coatings	450	350
Fire-retardant coatings		
- Clear	650	
- Pigmented	350	
Flats	250	100
Floor coatings	420	
Graphic arts (sign) coatings	500	
Industrial maintenance (im) coatings	420	
High temperature im coatings		
Zinc-rich im primers	420	
Japan/faux finishing coatings	700	350
Magnesite cement coatings	600	450
Mastic coatings	300	
Metallic Pigmented coatings	500	
Multicolor coatings	420	250
Nonflat coatings	250	150
Nonflat high gloss	250	
Pigmented lacquer	680	550
Pretreatment wash primers	780	
Primers, sealers, undercoaters	350	
Quick-dry enamels	400	
Quick-dry primers, sealers, undercoaters	350	

Recycled coatings	250	
Roof coatings	300	
Aluminum roof coatings	500	
Roof primers, bituminous	350	
Rust: preventive coatings	420	
Shellac		
- Clear	730	
- Pigmented	550	
Specialty primers	350	
Stains	350	
- Interior	250	
Swimming pool coatings		
- Repair	650	
- Other	340	
Traffic coatings	250	150
Waterproofing sealers	400	
Waterproofing concrete, masonry sealers	400	
Wood preservatives – Belowground	350	
Other	350	

Table 6: Paints and coatings VOC limits (Source: LEED, 2009)

411.23 ***Flooring Systems***

Flooring and floor coverings used on interiors should meet the requirements established on the following standards:

Option 1	
Carpet	Meet testing and product requirements of the Carpet and Rug Institute's Green Label Plus program.
Carpet cushion	Meet requirements of the Carpet and Rug Institute Green Label program.
Carpet adhesives	Meet VOC limit of 50 g/L
Hard surface flooring	Meet the testing and product requirements of FloorScore certification.
Floor finishes	Meet the requirements of South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings.
Tile setting adhesives and grout	Meet the South Coast Air Quality Management District (SCAQMD) Rule 1168
Tile, masonry, terrazzo, cut stone, and solid wood flooring without coatings or sealants	Does not require testing
Option 2	
All flooring elements installed in the building interior	Meet the testing and product requirements of the California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

Table 7: Flooring systems requirements

411.24 *Composite Wood and Agrifiber Products*

Composite wood and agrifiber products used on the interior of the building shall contain no added urea-formaldehyde resins. Urea formaldehyde is commonly used in composite wood products such as hardwood plywood, particleboard, wheatboard, strawboard and medium density fiberboard (mdf). Adhesives and sealants described on section 411.21 should be considered instead of urea-formaldehyde resins.

411.3 *Thermal Properties of Building Materials*

Thermal insulation can be defined as the reduction of heat transfer between objects or surfaces. Heat transfer is an inevitable consequence of contact between objects of different temperature. Thermal insulation is used to keep buildings at a comfortable temperature by reducing the flow of heat through the exterior surfaces of the building. The choice of the insulating product and the amount of insulation required will depend on the climate, latitude and altitude of the building.

In building construction, insulating materials are assigned a quantitative measure of insulating capability called the R-value; R-values are expressed using the metric units in m2.K/W. The higher the R-value, the better the material is at resisting energy transfer.

The K-value measures the heat loss rate for a specific material, thickness, area, and temperature difference. The U value measures the ability of a substance to allow the transfer of heat. This means that the higher the U and K value the worse the thermal performance of the material or building envelope. Its units are expressed in W/m^2K.

The difference between U and K value is that K-value only measures the heat loss for a specific material, while the U value measures the heat transfer of a building element such as a wall, floor or roof.

The U value is the inverse sum of the resistances of each building material and surface. Because the interaction of the building element to the outside environments is measured in terms of surface resistance, the behavior of the built elements is also expressed in terms of resistances.

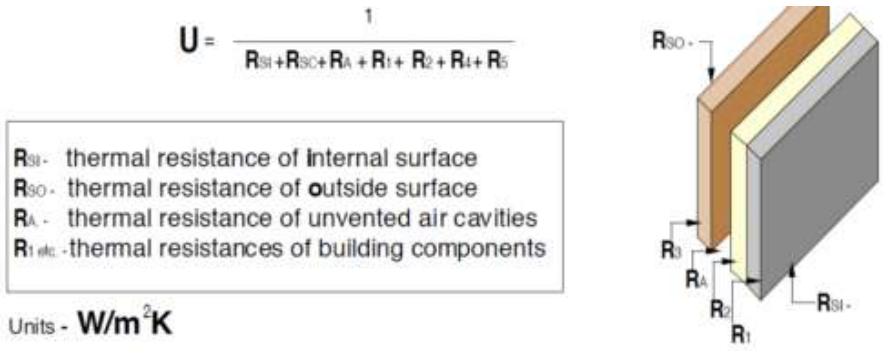


Figure 44: U value diagram (Source: architecture.com)

The following image illustrates a section of a wall composed by three elements; each element has a certain thickness "L", and a coefficient for thermal conductivity λ, resulting in three different R-values and one U-value for the complete building element.

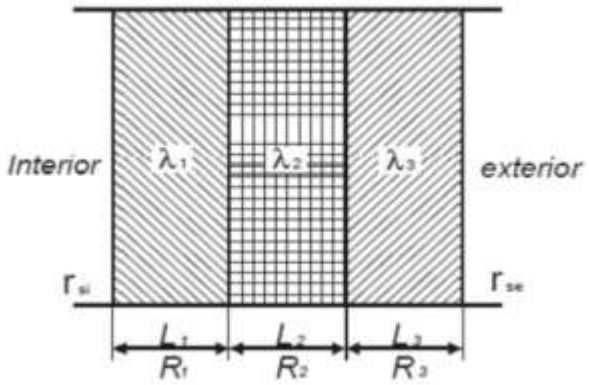


Figure 45:Wall R value diagram

The document "Taller para el Aislamiento térmico en una vivienda" found in the following link, provides procedures and practical examples to perform U-value calculations for different elements:

http://www.cmic.org/comisiones/sectoriales/vivienda/2010/conavi/lo_nuevo/Taller_termico/TercerModulo.pdf

The following table illustrates U-value calculations for different wall and roof assemblies.

Description	U-value "U" (W/m^2K)
Wall Assembly Stucco (0.005 m) CMU (0.20 m) Rigid Extruded Polystyrene (0.02 m) Stucco (0.005)	$\frac{1}{\frac{1}{8.1}+\frac{0.005}{0.72}+\frac{0.20}{0.19}+\frac{0.02}{0.034}+\frac{0.005}{0.72}+\frac{1}{13}}$ =0.539
Roof Assembly Corrugated metal 22 ga. (0.0007 m) Polyisocyanurate foam (0.03 m) Concrete (0.10 m)	$\frac{1}{\frac{1}{6.6}+\frac{0.0007}{45}+\frac{0.03}{0.030}+\frac{0.10}{0.17}+\frac{1}{13}}$ =0.550
Green Roof Assembly Lightweight concrete slab (0.20 m) Polyisocyanurate foam (0.02) Green roof (0.40 m)	$\frac{1}{\frac{1}{6.6}+\frac{0.20}{0.17}+\frac{0.02}{0.030}+\frac{0.40}{0.032}+\frac{1}{13}}$ =0.068

Table 8: U-value calculations for different constructive elements

411.31 ***Building Envelope Requirements Based on ASHRAE 90.1-2007***

The standard ASHRAE 90.1-2007, mentioned on the LEED™ Reference Guide for Green Building Design and Construction, establishes minimum insulation values for the building envelope of energy efficient buildings. The values established on ASHRAE should be taken in consideration during the design and construction phase of VESTA's buildings to guarantee its adequate energy performance.

To establish building envelope requirements three different locations for VESTA's industrial properties were chosen. The site selection attempted to include the different weather conditions VESTA's properties could face. The selected locations and their climate zone according to ASHRAE 90.1-2007 are:

- *Tijuana: Climate zone 2B*
- *Queretaro: Climate zone 3A*
- *Cancun: Climate zone 1A*

The Building envelope requirements for this three climate zones are established in the following table.

Climate Zone 1A		
Opaque Elements	**Assembly** Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F/BTU$)
Roofs		
Insulation Entirely above Deck	0.358 (0.063)	2.64 (15.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.193 (0.034)	5.28 (30.0)
Walls, Above-Grade		
Mass	3.293 (0.580)	NR
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.704 (0.124)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)
Walls, Below-Grade		
Below-Grade Wall	6.473 (1.140)	NR
Floors		
Mass	1.828 (0.322)	NR
Steel-Joist	1.987 (0.350)	NR
Wood-Framed and Other	1.601 (0.282)	NR
Slab-On-Grade Floors		
Unheated	4.145 (0.730)	NR
Heated	5.792 (1.020)	1.32 (7.50)
Opaque Doors		
Swinging	3.975 (0.700)	
Nonswinging	8.233 (1.450)	

Fenestration	Assembly Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	Assembly Maximum SHGC
Vertical Glazing, 0%-40% of Wall		
Nonmetal framing (all)[b]	6.814 (1.200)	0.25 all
Metal framing (curtainwall/ storefront)[c]	6.814 (1.200)	
Metal framing (entrance door)[c]	6.814 (1.200)	
Metal framing (all other)[c]	6.814 (1.200)	
Skylight with Curb, Glass, % of Roof		
0% - 2.0%	11.242 (1.980) all	0.36 all
2.1% - 5.0%	11.242 (1.980) all	0.19 all
Skylight with curb, Plastic, % of roof		
0% - 2.0%	10.788 (1.900) all	0.34 all
2.1% - 5.0%	10.788 (1.900) all	0.27 all
Skylight without Curb, All, % of Roof		
0% - 2.0%	7.722 (1.360) all	0.36 all
2.1% - 5.0%	7.722 (1.360) all	0.19 all

Climate Zone 2B		
Opaque Elements	**Assembly** Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F/BTU$)
Roofs		
Insulation Entirely above Deck	0.273 (0.048)	3.52 (20.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.153 (0.027)	6.69 (38.0)
Walls, Above-Grade		
Mass	0.857 (0.151)[a]	1.00 (5.70 c.i.[a])
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.704 (0.124)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)
Walls, Below-Grade		
Below-Grade Wall	6.473 (1.140)	NR
Floors		
Mass	0.608 (0.107)	1.11 (6.30 c.i.)
Steel-Joist	0.295 (0.052)	3.35 (19.0)
Wood-Framed and Other	0.290 (0.051)	3.35 (19.0)
Slab-On-Grade Floors		
Unheated	4.145 (0.730)	NR
Heated	5.792 (1.020)	1.32 (7.50)
Opaque Doors		
Swinging	3.975 (0.700)	
Nonswinging	8.233 (1.450)	

Fenestration	Assembly Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	Assembly Maximum SHGC
Vertical Glazing, 0%-40% of Wall		
Nonmetal framing (all)[b]	4.259 (0.750)	0.25 all
Metal framing (curtainwall/ storefront)[c]	3.975 (0.700)	
Metal framing (entrance door)[c]	6.246 (1.100)	
Metal framing (all other)[c]	4.259 (0.750)	
Skylight with Curb, Glass, % of Roof		
0% - 2.0%	11.242 (1.980) all	0.36 all
2.1% - 5.0%	11.242 (1.980) all	0.19 all
Skylight with curb, Plastic, % of roof		
0% - 2.0%	10.788 (1.900) all	0.39 all
2.1% - 5.0%	10.788 (1.900) all	0.34 all
Skylight without Curb, All, % of Roof		
0% - 2.0%	7.722 (1.360) all	0.36 all
2.1% - 5.0%	7.722 (1.360) all	0.19 all

Climate Zone 3A		
Opaque Elements	**Assembly** Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F/BTU$)
Roofs		
Insulation Entirely above Deck	0.273 (0.048)	3.52 (20.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.153 (0.027)	6.69 (38.0)
Walls, Above-Grade		
Mass	0.698 (0.123)	1.34 (7.60 c.i.)
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.477 (0.084)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)
Walls, Below-Grade		
Below-Grade Wall	6.473 (1.140)	NR
Floors		
Mass	0.608 (0.107)	1.11 (6.30 c.i.)
Steel-Joist	0.295 (0.052)	3.35 (19.0)
Wood-Framed and Other	0.290 (0.051)	3.35 (19.0)
Slab-On-Grade Floors		
Unheated	4.145 (0.730)	NR
Heated	5.110 (0.900)	1.76 (10.0)
Opaque Doors		
Swinging	3.975 (0.700)	
Nonswinging	8.233 (1.450)	

Fenestration	Assembly Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	Assembly Maximum SHGC
Vertical Glazing, 0%-40% of Wall		
Nonmetal framing (all)[b]	3.691 (0.650)	0.25 all
Metal framing (curtainwall/ storefront)[c]	3.407 (0.600)	
Metal framing (entrance door)[c]	5.110 (0.900)	
Metal framing (all other)[c]	3.691 (0.650)	
Skylight with Curb, Glass, % of Roof		
0% - 2.0%	6.643 (1.170) all	0.36 all
2.1% - 5.0%	6.643 (1.170) all	0.19 all
Skylight with curb, Plastic, % of roof		
0% - 2.0%	7.381 (1.300) all	0.65 all
2.1% - 5.0%	7.381 (1.300) all	0.34 all
Skylight without Curb, All, % of Roof		
0% - 2.0%	3.918 (0.690) all	0.39 all
2.1% - 5.0%	3.918 (0.690) all	0.19 all

Table 9: ASHRAE 90.1-2007 Insulation requirements

c.i. = continuous insulation
NR = no (insulation) requirement
a = Exception to Section A3.1.3.1 applies
b = Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding
c = Metal framing includes metal framing with or without thermal break. The “all other” subcategory includes operable windows, fixed windows, and non-entrance doors.

420 Preliminaries

The following section provides information about how to develop an erosion and sedimentation plan, a habitat protection plan and a construction indoor air quality management plan, to guarantee a sustainable development of the site and healthy conditions for workers during construction.

421 Erosion and Sedimentation Control Plan

The consequences of soil erosion and sedimentation are significant. High suspended sediment concentrated in streams and lakes can increase the cost of water treatment, inhibit light penetration and photosynthesis. Sediment can lead to the development of sludge deposits and anaerobic conditions when untreated wastewater is discharged in the aquatic environment, causing destruction of aquatic ecosystems. Sediment also acts as a vehicle for transportation of other possibly damaging pollution, like PCB's and other industrial compounds, nutrients, insecticides and pesticides, and toxic metals as lead.

On-site and off-site effects of erosion and sedimentation:

On-site
Loss of topsoil
Undermining of roads and utilities
Traffic problems and road safety issues associated with mud on roads
Clogged drains and increased flooding
Loss of capacity in sediment basins
High cost for reconstruction and maintenance
Off-site
Sedimentation in reservoirs and storage structures, with loss of water storage capacity
Instability of stream channels caused by increased runoff and sedimentation loads
Sedimentation of rivers cause a reduction in channel capacity increasing frequency of floods
Smothering of aquatic and marine flora and fauna
Land degradation
Loss of navigable reaches of a river or watercourse
Decline or total loss of recreational and commercial fishing, as a result of increased turbidity
Reduced recreational and aesthetic value of riverbanks and waterways

Table 10: Effects of erosion and sedimentation (Source: Ooshaksaraie Leila et.al)

To reduce pollution from construction activities an erosion and sedimentation control plan should be created and implemented. Erosion prevention is the practice of protecting the soil surface and preventing the soil particles from being detached by rainfall or wind. Sediment control is the practice of trapping soil particles after they have been detached and moved by wind or water.

The erosion and sedimentation control plan must describe the measures implemented to accomplish the following objectives:

- *Prevent loss of soil during construction by stormwater runoff and/or wind erosion.*
- *Prevent sedimentation of storm sewers or receiving streams.*

- *Prevent pollution of the air with dust and particulate matter.*

It is highly advisable that the erosion and sedimentation plan complies with *the 2003 EPA Construction General Permit requirements*, more information can be found at: http://cfpub.epa.gov/npdes/stormwater/cgp.cfm

Implementation

During the design phase an *Erosion and Sedimentation Control Plan* should be developed by the civil engineer or landscape architect. The general contractor should work with the project team to implement the plan during construction and throughout the project completion. The plan should be included in construction documents outlining the team member's and subcontractors' responsibilities for installing, maintaining, using and documenting the specified erosion and sedimentation control best management practices.

As a minimum the Erosion and Sedimentation control Plan should include:

- *A natural resources map identifying soils, forest cover, and other resources protected under code.*
- *A sequence of construction of the development site, identifying the date on which clearing will begin, duration, areas of clearing, installation of temporary and permanent erosion and sediment control measures.*
- *Erosion and sediment control measure necessary to meet the objectives of EPA's regulation throughout all phases of construction and after completion of development of the site.*
- *Seeding mixtures and rates, types of sod, method of seedbed preparation, expected seeding dates, type and rate of lime and fertilizer application, kind and quantity of mulching for temporary and permanent vegetative control measures.*
- *Provision for maintenance of control facilities, including easements and estimates of the cost of maintenance.*

Strategies

Protect and maximize existing native vegetation and natural forest floor: natural vegetation can act as a natural buffer between construction and wetlands, streams, lakes, and water bodies.

Figure 46: Erosion and sedimentation control – protect and maximize existing vegetation

Use mulching and temporary seeding: use fast-growing grasses or place hay, woodchips, straw, or gravel to temporarily cover and hold the soils.

Figure 47: Erosion and sedimentation control – use mulching and temporary seeding

Sediment fences: use sediment fences to filter out soil from water and prevent erosion on development sites.

Figure 48: Erosion and sedimentation control – use sediment fences

Sedimentation basin: built temporary barriers or dams to intercept sediment runoff and remove the sediment.

Figure 49: Erosion and sedimentation control - sedimentation basins

Earth dike: construct a mound of stabilized soil to channel water to a desired location.

Figure 50: Erosion and sedimentation control – earth dikes

Vehicle tracking: use gravel beds on the entrance/exit of vehicles to avoid earth and pollutants dispersion. Instruct all vehicles to remove soil and loose material from their wheels and undercarriage when leaving the work area.

Figure 51: Erosion and sedimentation control – vehicle tracking (Source: aspent.com)

422 Habitat Protection Plan

A habitat protection plan seeks to conserve and protect habitat areas for wild plants and animal throughout preserving natural areas on a site, limiting disturbance during and after construction.

All site disturbances must be limited to the following parameters to conserve existing natural areas and protect existing habitat:

- *12 meters beyond the building perimeter.*
- *3 meters beyond surface walkways, patios and surface parking.*
- *5 meters beyond primary roadway curbs and main utility trenches.*
- *8 meters beyond constructed areas with permeable surfaces that requires additional staging areas to limit compaction in the constructed area.*

Implementation

During construction, clearly mark construction and disturbance boundaries and note the site protection requirements in construction documents. The contractor should specify lay-down, recycling, and disposal areas and use paved areas for staging activities. The cost and benefit of contractual penalties if protected areas outside the construction boundaries are destroyed should be considered.

The following figure illustrates a habitat protection plan.

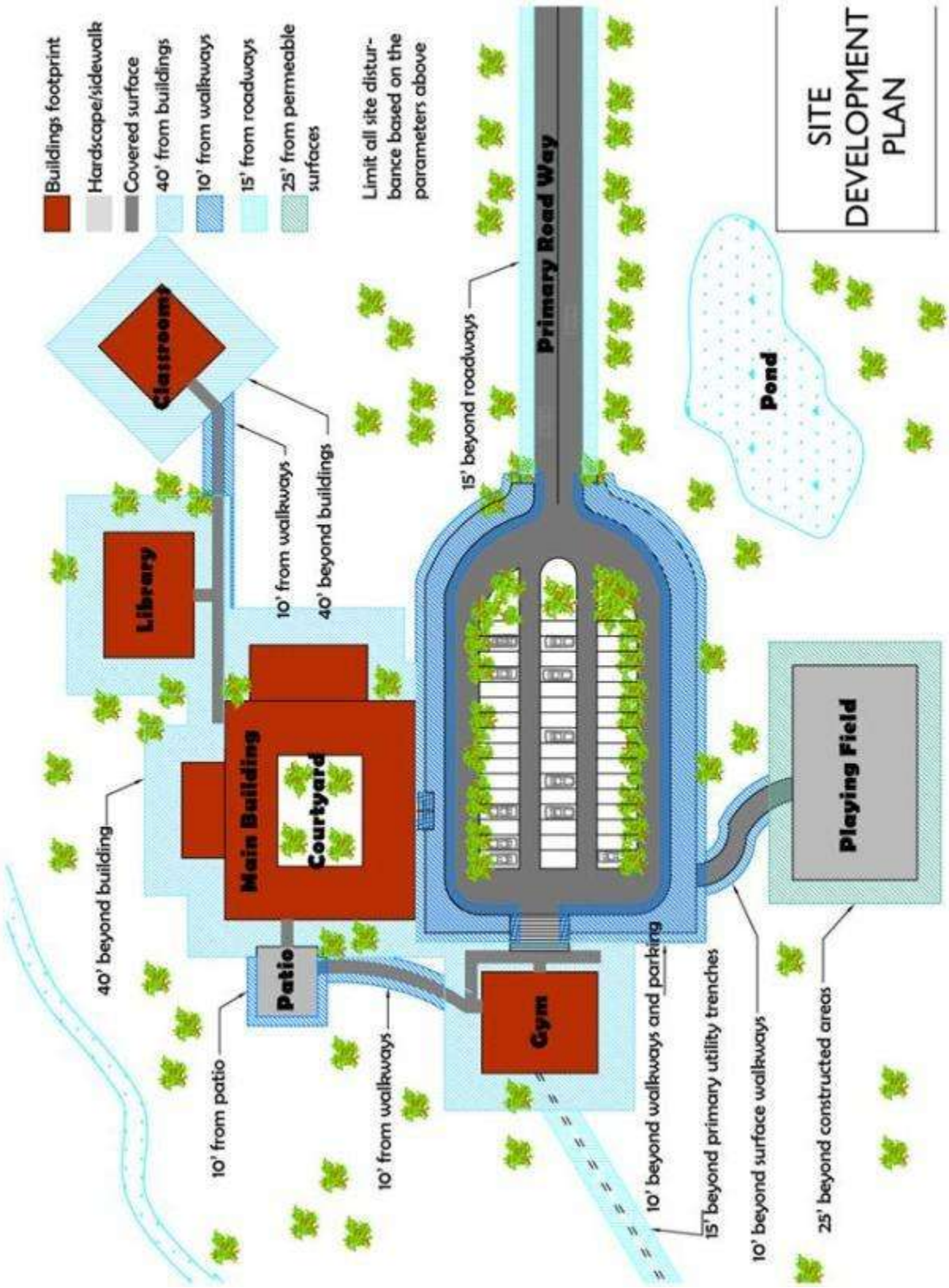


Figure 52: Example of a Habitat Protection Plan (Source: LEED User, 2011)

423 Construction Indoor Air Quality Management Plan – During Construction

Indoor air quality on the construction site may be poor due to improper ventilation, the presence of hazardous and volatile chemicals, dust, and moisture. Poor air quality can result in health implications for the individuals working on the construction. A construction Indoor Air Quality Management (IAQ) Plan – During construction, documents the construction methods that will be used to maintain indoor air quality during the construction process. The purpose of an IAQ plan is to protect the health of workers on the site, and prevent residual IAQ issues once the building is finished and sealed.

Develop and implement an IAQ management plan for the construction and preoccupancy of the building that meets or exceeds the recommended control measures of the Sheet Metal and Air Conditioning National contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (chapter 3). For more information visit the website: www.smacna.org.

For an outline of a construction indoor air quality management refer to appendix 2.

Implementation

The referenced SMACNA standard recommends control measures in the following five basic areas:

1. HVAC Protection: Avoid the use of HVAC systems during construction since the equipment can become contaminated and damaged. Protect all HVAC equipment from both dust and odors and seal all duct and equipment opening with plastic. If the HVAC system must be operated during construction, the contractor must install and maintain temporary filters over grilles and openings, the filtration medium must have a rating of MERV 8 or better. Once the construction is completed and previous to occupancy of the building the contractor should replace all filters. Consider using temporary ventilation units, it is a feasible, practical and generally not costly alternative.

Figure 53:Air quality management plan – HVAC protection (Source: mcaagreen.org)

2. Source Control: Specify finish materials (paints, carpets, composite wood, adhesives and sealants) that have low-toxicity levels or none at all. Recover, isolate, and ventilate containers housing toxic materials. Exhaust fumes from idling vehicles and gasoline and diesel fueled tools.

Figure 54: Air quality management plan – Source control (Source: njeja.org)

3. Pathway Interruption: During construction, the contractor must isolate areas of work to prevent contamination of clean or occupied spaces, and ventilate spaces during installation of Volatile Organic Compounds emitting materials.

Figure 55: Insolation of construction area from remainder of building (Source: Harvard Green Campus Initiative)

4. Housekeeping: The maintenance team should protect porous materials from exposure to moisture and store them in a clean area before installation. Cleaning activities should be instituted to control contaminants during construction and before occupancy.

Figure 56: Materials kept off the floor to avoid damage and exposure to moisture
(Source: Harvard Green Campus Initiative)

5. Scheduling: The design and construction team should coordinate construction activities to minimize the impact on indoor air quality, some construction activities might be conducted during off hours to allow time for new materials to air out. Flush out and indoor air quality test procedures should be scheduled before occupancy.

424 Construction Waste Management

The U.S. Environmental Protection Agency (EPA) estimated 136 million tons of building related waste generated during 1998, equivalent to 25% - 40% of the national waste stream. A 2003 update shows an increase to 164,000 million tons of yearly construction waste.

Responsibly managing waste on a construction jobsite is essential for sustainable constructions. The greatest benefit of construction waste management is reducing the total waste generated by the building industry. Recycling of construction and demolition debris reduces demand of virgin resources and environmental impacts associated with resource extraction, processing and transportation.

The recycling and/or salvaging of nonhazardous construction and demolition debris should be encouraged. A construction waste management plan should be developed and implemented during construction of VESTA's buildings, the plan must identify the materials to be diverted from disposal and whether the materials will be sorted on site or comingled.

Refer to appendix 3 for a sample outline of a Construction Waste Management Plan.

Figure 57: Construction waste management (Source: wrap.org.uk)

430 Building Shell

The analysis of the proposed building shell (Vesta Inventory III Buildng) in addition to the analysis of current sustainable codes, standards (LEED C&S, ASHRAE, 90.1-2007, etc.) and best practices were used to identify opportunity areas for the incorporation of sustainable strategies and technologies in VESTA's properties. The identified areas of opportunity and the proposals made to increase sustainability in VESTA's building shells are further detail on this section.

Figure 58: TypicalVesta's building shell property

431 Structural Components

Among the identified areas of opportunity for VESTA's building shells is the use of appropriate insulation in the building envelope to maximize thermal comfort while decreasing energy consumption. Roofing materials with a high Solar Reflectance Index can be used to minimize heat island effect, materials with a high recycle content can reduce raw materials consumption, and materials and finishes with low VOCs can increase indoor air quality.

431.1 *Structure*

Concrete

The technical specification for concrete structures will be determined by the competent authority on the project. However, he must seek to incorporate recycled materials and/or available materials on site to reduce environmental impact of VESTA's buildings.

- *Fly Ash is a noncombusted by product of coal fired power plants that generally ends up in landfills, but which can be incorporated on concrete structures (as pre-consumer recycled content), substituting between 15% and 30% of Portland cement. The following table offers a comparison between high volume fly ash concrete and conventional concrete.*

Conventional Concrete	High Volume Fly Ash Concrete
Energy intensive manufacture	Less energy intensive manufacture
Weaker ultimate strength	Higher ultimate strength
Less durable	More durable
Requires more water	Requires less water
Uses virgin materials only	Uses a waste by-product
Creates more global warming gases	Creates fewer global warming gases

Table 11: Comparison between conventional concrete and high volume fly ash concrete

- *Besides using materials with recycled content such as concrete with fly ash, the byproduct of excavation activities should be incorporated as a concrete aggregate when possible, to reduce the use of raw materials.*

Table 12 provides information about companies that incorporate fly ash in their products, for further information about those products refer to appendix 4.

CEMEX	**Product:**	CEM2 & CEM3 blended cements
	Description:	CEM2 - Cementitious product that reuses Fly ash, and reduces cabon dioxide emissions by 25% for each tonne produced. CEM3 – Cementitious product that reuses products from the iron or steel industries, reducing carbon dioxide levels by 49% for each tone produced.
Holcim	**Product:**	Envirocore (Cass C and Class F)
	Description:	Envirocore products utilize or incorporate recycled materials that may contribute to achieve LEED certification. Envirocore products are in accordance with international standards ASTM C 618 Standard and AASHTO M 295 Standard.

Table 12: Providers of concrete with fly ash aggregates in Mexico

Structural Steel

Structural steel has a high recycled content value. LEED takes into consideration 25 percent pre-consumer recycle content for structural steel by default. However, it is important to employ structural steel that is considered regional material, meaning that is extracted and processed within an 800 kilometer radius from the project.

431.2 *Walls*

Thermal comfort is a state of mind in which people expresses satisfaction with their surrounding thermal environment. This term is frequently used by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), since one of the most important goals of HVAC engineers is maintaining thermal comfort on buildings.

One way of reducing HVAC energy consumption while maintaining thermal comfort within the buildings is through the use of thermal insulation in the building envelope. Thermal insulation reduces the thermal load for residential, commercial and industrial buildings, reducing electric consumption by up to 40%.

The minimum thermal insulation requirements for walls in VESTA's industrial shells to ensure thermal comfort for the three chosen locations are:

	Wall's Insulation Requirements	
	Assembly Maximum U-value W/m^2K (BTU/$Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F$/BTU)
Climate Zone 1A (Cancun)		
Mass	3.293 (0.580)	NR
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.704 (0.124)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)
Climate Zone 2B (Tijuana)		
Mass	0.857 (0.151)[a]	1.00 (5.70 c.i.[a])
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.704 (0.124)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)
Climate Zone 3A (Queretaro)		
Mass	0.698 (0.123)	1.34 (7.60 c.i.)
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.477 (0.084)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)

Table 13: ASHRAE wall insulation requirements for the proposed climate zones

Table 14 shows the R-values for different concretes. A solid concrete (normal weight) tilt-up wall with an 8" thickness (as shown in base case floor plans) will have an approximated R-value of 0.16 M^2K/W (0.90 $Ft^2h°F$/BTU), equivalent to an U-value of 6.473 W/m^2K (1.14 BTU/$Ft^2h°F$).

Concrete Density and R-Value		
Concrete type	**Density (lbs/c.f.)**	**R-value M^2K/W ($Ft^2h°F/BTU$) per inch**
Insulating lightweight	20	0.25 (1.430)
	30	0.18 (1.000)
	40	0.15 (0.830)
	50	0.12 (0.670)
	60	0.09 (0.520)
	70	0.08 (0.450)
	80	0.07 (0.370)
	90	0.05 (0.300)
Structural lightweight	100	0.04 (0.240)
	110	0.03 (0.190)
	120	0.02 (0.140)
	130	0.02 (0.110)
Normal weight	140	0.01 (0.083)
	145	0.01 (0.075)
	150	0.01 (0.065)

Table 14: Concrete R-values

Complying with insulation requirements for walls established on table 13 would require the use of additional insulation. Figure 59 illustrates the current constructive structure and proposed insulating system to comply with insulation requirements.

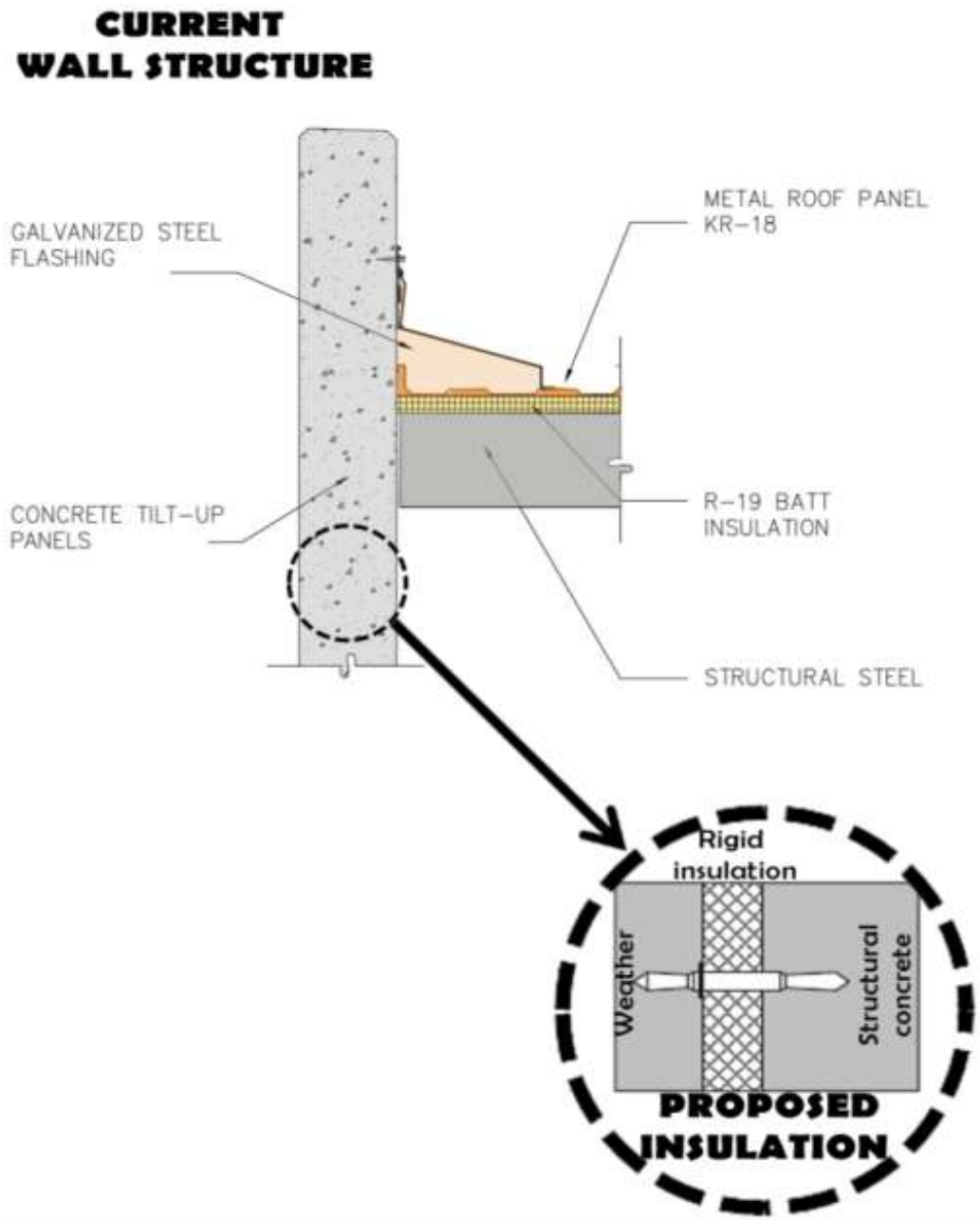


Figure 59: Diagram of proposed wall insulation

Rigid insulation is being proposed to comply with VESTA's insulation requirements. Owens Corning's Pinkcore™ is a rigid insulating technology specifically designed to work with tilt-up panels. This technology can be used to achieve the required R values for walls in VESTA's Industrial Parks proposed locations.

The proposed wall insulation for Vesta's warehouses in the three proposed locations can be seen on the following table.

Pinkcore™ insulation		
Warehouse location	**Insulating material**	**Material R-value M^2K/W ($Ft^2h°F/BTU$)**
Cancun	1" Owens Corning's Pinkcore ™	0.88 (5.00)
Tijuana	1 ½" Owens Corning's Pinkcore ™	1.32 (7.50)
Queretaro	1 ½" Owens Corning's Pinkcore ™	1.32 (7.50)

Table 15: Proposed wall insulation using pinkcore system

Pinkcore® extruded polystyrene rigid insulation and ties are designed to provide a fast, efficient method of constructing insulated walls. Pinkcore panels create a water resistant and thermally efficient continuous insulation envelope, while Pinkcore ties (molded from a high performance, thermoplastic resin with low thermal conductivity) are designed to hold a face wythe of concrete without the need for thermally inefficient metal connectors or solid concrete sections. For further information about Pinkcore® system and technical data sheets please refer to appendix 4.

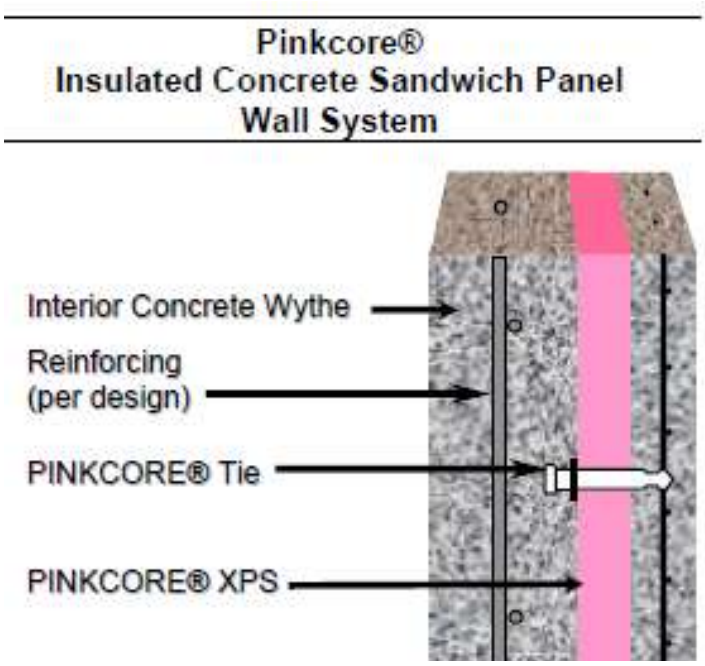


Figure 60: Pinkcore concrete sandwich panel wall system

Pinkcore™ system wall's assemblies				
	Proposed wall assembly			Maximum U-value requirement
Material	**Thickness (inches)**	**R-Value M^2K/W ($Ft^2h°F/BTU$)**	**U-value W/m2K (BTU/Ft2h°F)**	
Cancun				
Tilt-up panel structural concrete	7 ¼"	0.14 (0.77)	-	-
Pinkcore®	1"	0.88 (5.00)	-	-

insulation				
External concrete layer (weather)	2”	0.04 (0.22)	-	-
Total	**10 ¼”**	**1.05 (5.99)**	**0.948 (0.167)**	**3.293 (0.580) OK**
Tijuana				
Tilt-up panel structural concrete	7 ¼”	0.14 (0.77)	-	-
Pinkcore® insulation	1 ½”	1.32 (7.50)	-	-
External concrete layer (weather)	2”	0.04 (0.22)	-	-
Total	**10 ¾”**	**1.50 (8.49)**	**0.670 (0.118)**	**0.857 (0.151) OK**
Queretaro				
Tilt-up panel structural concrete	7 ¼”	0.14 (0.77)	-	-
Pinkcore® insulation	1 ½”	1.32 (7.50)	-	-
External concrete layer (weather)	2”	0.04 (0.22)	-	-
Total	**10 ¾”**	**1.50 (8.49)**	**0.670 (0.118)**	**0.698 (0.123) OK**

Table 16: Insulation values for walls using Pinkcore system.

As an alternative to Pinkcore for VESTA’s warehouses walls, Cemex’s concrete “Concreto Ahorrador de Energia (CAE)”, which poses thermal insulation properties and could be used instead of regular concrete for tilt-up walls, was considered. However, the thermal insulation properties of the material are inferior to that of the Pinkcore system, reaching an R-value of 0.015 m^2K/W and a K-value of 68.30 W/m^2K per centimeter (only 0.683 W/m^2K per meter of thickness), that would result in extremely thick walls to reach the required insulation established on table 13, but it could be used for Cancun where there are less insulation requirements.

Table 17 shows the required thickness in case CAE concrete is used as insulating material for walls. For further information about CAE refer to appendix 4.

Cemex’s Concreto Ahorrador de Energia (CAE) walls proposals			
Proposed wall assembly to comply with required insulation			**Maximum U-value requirement**
Material	**Thickness (cm)***	**U-value W/m2K**	
Cancun			
Tilt-up panel made of CAE	0.25	2.732	3.293 **OK**
Tijuana			
Tilt-up panel made of CAE	0.80	0.854	0.857 **OK**
Cancun			
Tilt-up panel made of CAE	1.00	0.683	0.698 **OK**

Table 17: Insulation values for walls using CAE technology

A wall assembly using Pinkcore™ and insulated corrugated metal can be used as an alternative to reduce the initial investment in the building envelope while complying with the required insulation for the proposed location. See figure below.

Figure 61: Wall assembly using pinkcore and insulated corrugated panels

The bottom part of the wall (the first 3 meters) would be using the Pinkcore™ insulating system, as specified on table 16, while the upper part of the wall would be composed of corrugated metal and faced MBI fiberglass.

Figure 62: Faced MBI fiberglass wall

The upper part of the wall would have to comply with the insulating values specified on table 18 (R-13 fiberglass rolls would be required for the three locations).

	Wall's Insulation Requirements	
	Assembly Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F/BTU$)
Climate Zone 1A (Cancun)		
Metal Building	0.642 (0.113)	2.29 (13.0)
Climate Zone 2B (Tijuana)		
Metal Building	0.642 (0.113)	2.29 (13.0)
Climate Zone 3A (Queretaro)		
Metal Building	0.642 (0.113)	2.29 (13.0)

Table 18: Insulation requirements for metal wall assemblies as specified in ASHRAE 90.1

Fiberglass insulation has an approximated R value of 4 per inch thickness, meaning that the system used for the upper part of the wall assembly would required faced MBI fiberglass around 3" thick. However, the R value of the material can vary depending on the provider. The contractor would have to verify that the proposed material complies with values specified on table 18.

Among the providers of faced MBI fiberglass in Mexico are:

Owens Corning
(55) 5089 6767
Alejandra Flores: alejandra.flores@owenscorning.com
Jacqueline Jiménez: jacqueline.jimenez@owenscorning.com
Protección Térmica Arizpe
Poniente 122 No. 524 Col. Industrial Vallejo 02300 México, D.F.
Tel y Fax: (55) 5587 4988 / 5368 0585 / 5567 2388
protarsa@prodigy.net.mx
Termatek
Amado Nervo 2820 Nte., Monterrey, N.L., México
8331 5491 / 8331 5493
construcción@termatek.com.mx

Table 19: Faced MBI fiberglass providers

431.3 *Floors*

It is important to select flooring materials that require low maintenance, that are durable and environmentally friendly. Because of its low maintenance properties and durability VESTA currently utilize concrete flooring in its industrial properties. To increase its sustainability the building contractor should seek that all concrete flooring within the warehouse incorporates recycle content. Refer to section 431.1 for further information about concrete providers that incorporate fly ashes in their products. For information related to sustainable flooring finishes refer to section 432.

431.4 *Roofs*

Adequate building insulation will contribute to maintain thermal comfort within VESTA's building shells, reducing energy consumption related to the use of HVAC systems. The following table summarizes roof insulation requirements for an adequate thermal performance of VESTAS's buildings in the three chosen locations.

	Roof's Insulation Requirements	
	Assembly Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F/BTU$)
Climate Zone 1A (Cancun)		
Insulation Entirely above Deck	0.358 (0.063)	2.64 (15.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.193 (0.034)	5.28 (30.0)

Climate Zone 2B (Tijuana)		
Insulation Entirely above Deck	0.273 (0.048)	3.52 (20.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.153 (0.027)	6.69 (38.0)
Climate Zone 3A (Queretaro)		
Insulation Entirely above Deck	0.273 (0.048)	3.52 (20.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.153 (0.027)	6.69 (38.0)

Table 20: ASHRAE roof insulation requirements for the proposed climate zones

Currently VESTA's requires its developers to install Batt Insulation with a minimum R-19 value on its warehouses, according to the information stated on Vesta Inventory III Building Project Manual, considered the basecase building. Through the installation of R-19 Batt insulation, VESTAS's warehouses comply with roof insulation requirements for the three selected locations (a minimum R-19 insulation is suggested for the three locations, according to international regulations).

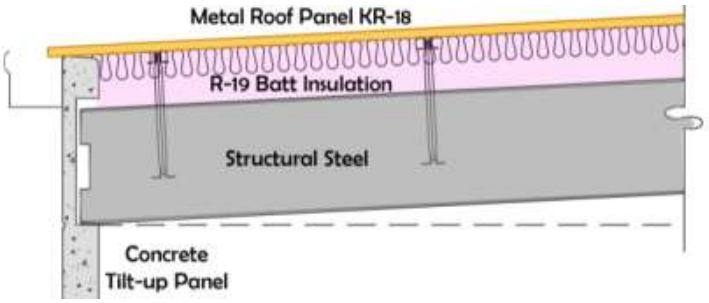


Figure 63: Vesta's current roof structure

431.41 *Solar Reflectance Index (SRI)*

A substantial amount of solar radiation is absorbed by roofs and walls, increasing cooling requirements to keep occupants inside the building comfortable. The use of reflective materials reduces thermal loads and cooling energy use on buildings. At least 75% of the roof surface area should have a finishing material with an SRI equal or greater than 78.

Commonly used roofing materials radiative properties			
	Solar Reflectance	Thermal Emittance	SRI
Metal (unpainted)	0.60 – 0.80	0.04 – 0.10	35 – 80
Metal (painted)	0.10 – 0.75	0.80	1 – 91
Asphalt shingles	0.05 – 0.25	0.90	0 – 25
Single ply membranes	0.70 – 0.80	0.85	85 - 99
Built up roofing	0.05 – 0.25	0.90	0 - 25
Concrete	0.20 – 0.70	0.90	19 - 86

Table 21: Roofing materials radiative properties Source: ORNL and LBNL

The SRI is a combination of the capacity of a material to reflect back radiation and heat into space. White coatings and light colored finishing materials are associated with high SRI values, so they should be procured for VESTA's building, while dark colored waterproofing materials should be avoided.

VESTA currently uses white metal coverings on its warehouses, which according to the U.S. DOE Energy Efficiency and Renewable Energy Department have a SRI around 90, complying with LEED requirements. However, the SRI of the product must be verified, because it can vary depending on the finishing materials or coverings. The metal roof provider should specify the solar reflectance index of its products. If the required SRI value is not met paint can be applied over the metal roof to comply with the requirements.

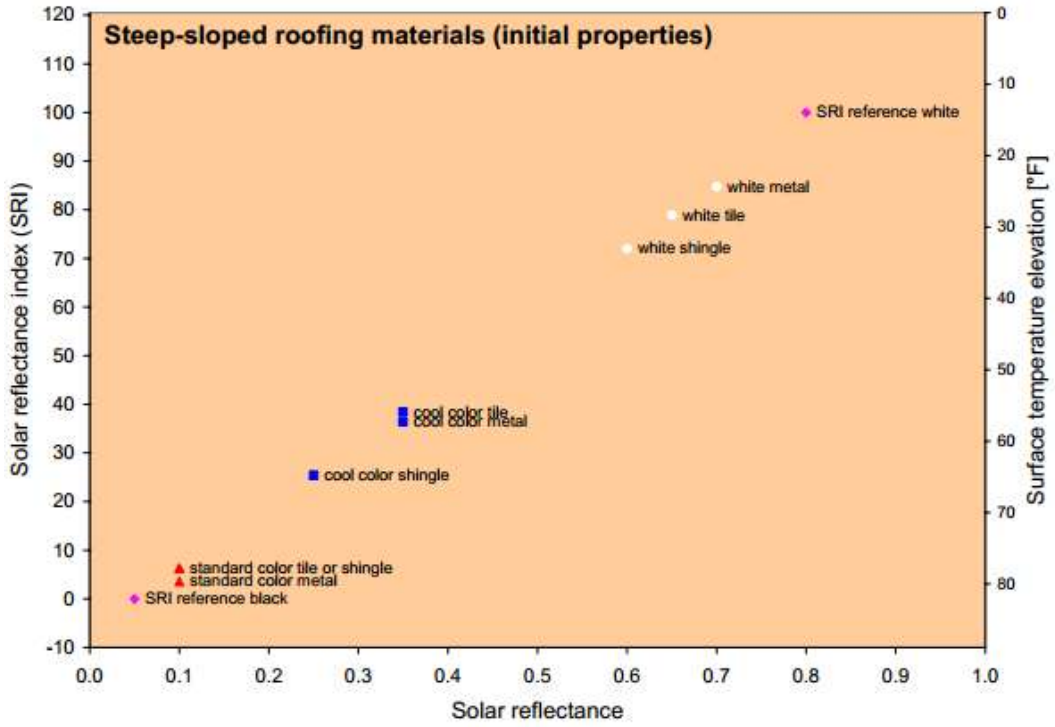


Figure 64: SRI of commonly used materials Source: eere.energy.gov

Some products that can be used as finishing materials on roofs and that contribute to comply with Solar Reflectance Index requirements are:

Company	Contact Information	Product
Sika	www.sika.com.mx 01-800-123-7452	PVC membrane coverings: - Sarnafil S 327-12 L - Sarnafil S 327-12 EL - Sikaplan 15G
Kynar	www.arkema-inc.com 55-5002-7100	Kynar 500® resins for cool metal roof

Table 22: roof covering's products

431.42 ***Green roofs***

The installation of green roofs contributes to increase roof insulation, reducing the amount of energy needed to maintain thermal comfort on interiors. Green roofs also decrease Urban Heat Island effect, through the use of vegetation that absorbs and transforms solar energy that otherwise would be release in the form of heat.

From a sustainable point of view it is advisable to install green roofs on Vesta's warehouses, especially in highly occupied areas like office spaces, where it can be used as insulation to decrease HVAC energy consumption and as additional recreational space for workers.

Access booth and detached office spaces are among the buildings where green roofs can be implemented. The benefit of installing vegetated roofs on this buildings is that no mayor structural requirements would be needed, making it more economically feasible.

If green roof are to be installed, native or adaptive vegetation should be used to minimize maintenance and water irrigation requirements. The following table suggests some native or adaptive vegetation that can be implemented into Vesta's Industrial Parks, considering the selected three site locations for Vesta's properties (Tijuana, Cancun and Queretaro).

Tijuana

	Scientific name: *Salvia mellifera* Common name: *Black sage* *California black sage*	Characteristics: *Openly branched* *Evergreen shrub* *0.90-1.80 meters tall* *Low water requirements*
	Scientific name: *Eriogonum fasciculatum* Common name: *Flat top buckwheat*	Characteristics: *Evergreen shrub* *0.90 meters tall* *1.20 diameter* *Low water requirements*
	Scientific name: *Abronia maritima* Common name: *Red sand verbena*	Characteristics: *0.90-1.80 meters tall* *Beach adapted perennial plant* *Moderate saline water requirements* *Full sun exposure*

Scientific name:
Simmondsia chinensis

Common name:
Jojoba

Characteristics:
1-2 meters tall
Evergreen
Drought resistant
Poisonous if ingested.

Scientific name:
Yucca shidigera

Common name:
Mojave yucca

Characteristics:
Perennial
4-11 meters tall
Fun sun exposure
Very low water requirements
With no summer water requirements

Queretaro

Scientific name:
Cardiospermum halicacabum

Common name:
Balloonvine
Love in a puff

Characteristics:
Climbing plant
With balloon like fruits
Can grow up to 3 meters in height
Moderate water requirements

Anisacanthus quadrifidus

Common name:
Flame honeysuckle
Hummingbird bush

Characteristics:
Full sun to partially shade exposure
1-2 meters tall
Low water use

Plumbago pulchella

Common name:
Flame honeysuckle
Hummingbird bush

Characteristics:
Up to 1 meter tall
Perennial

Scientific name:
Anisacanthus quadrifidus

Common name:
Cape leadwort
Skyflower

Characteristics:
.40-.80 meters tall
Average water needs
Drought tolerant
Evergreen perennial shrub

	Scientific name: *Bursera cuneata* Common name: *Copal*	Characteristics: *Small tree* *Perennial* *Low water requirements*
	Scientific name: *Bursera fagaroides* Common name: *Copal*	Characteristics: *4 meters tall* *Low to moderate sun exposure* *Low water requirements* *Slow growth rate*
Cancun		
	Scientific name: *Drypetes lateriflora* Common name: *Guiana-plum*	Characteristics: *6-9 meters tall* *Slow to moderate growth* *Moderate water requirements* *Light shade requirements*
	Scientific name: *Thrinax radiata* Common name: *Florida tatch palm*	Characteristics: *5-10 meters tall* *.10-.15 meters diameter* *Slow growth rate* *Salt water resistant* *Drought resistant*
	Scientific name: *Uncaria tomentosa* Common name: *Cat's Claw*	Characteristics: *Woody vine plant* *Up to 30 meters tall* *Drought resistant but found mostly in tropical jungles* *Fast growing rate*
	Scientific name: *Ammophila* Common name: *Marram grass,* *Bent grass,* *Beachgrass*	Characteristics: *Are able to thrive under shifting sands and high winds* *Low maintenance* *Evergreen* *Drought tolerant*

Table 23: Native vegetation palette for Vesta's selected locations

Green roof can be extensive, if simple plants such as sedum are used, or intensive if it includes plants as shrubs and trees. It is advisable to select an extensive green roof system for VESTA's buildings because it requires less maintenance. Figure 63 shows a section of a green roof indicating its typical components.

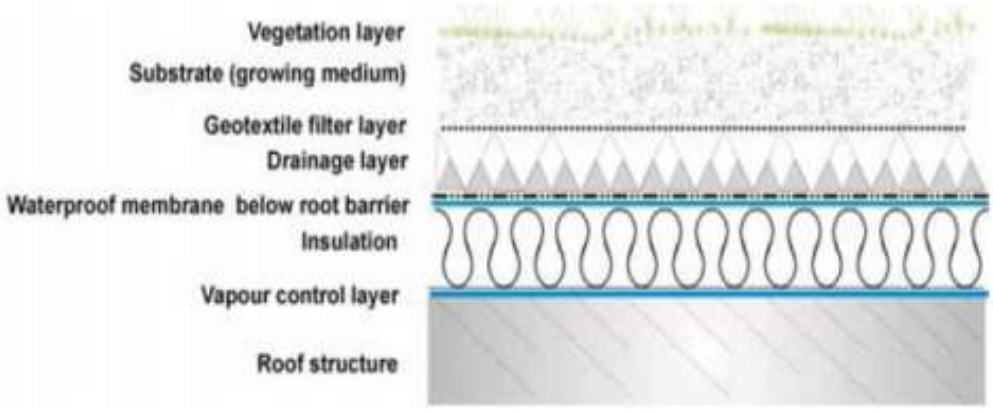


Figure 65: Section of a typical green roof system

Green roof dissipate heat absorbed through evapotranspiration and improve reflectivity of incident solar radiation. Studies about the thermal properties of green roofs have found that heat gain through an extensive green roof was reduced by an average of 70–90 % during the summer and heat loss by 10–30 % in winter.

For more information about Green Roof Systems, landscape design and Green Roof vegetation options refer to providers mentioned on the following table.

Green Roof Systems providers in Mexico	
	Bioconstrucción y Energía Alternativa S.A. de C.V. Río Mississippi 347-A Ote. Colonia del Valle San Pedro Garza Garcia, Nuevo Leon, Mexico 81-8040-8080 info@bioconstruccion.com.mx
	Biozotea Vicente Guerrero 142-A Col. Centro San Pedro Garza Garcia, Nuevo Leon, Mexico 81-8448-8350
	Green Roof Systems de Mexico Luis Spota No. 115-3, Col. San Simon Ticumac Benito Juarez, Mexico D.F. 55-1509-9237

Table 24: Green roof providers in Mexico

432 Finishes

During the selection process of interior and exterior finishes the following parameters should be taken into consideration:

- *Give preference to materials with higher recycled content*
- *All wood should be FSC certified*
- *Use products with low volatile organic compounds*
- *Give preference to rapidly renewable materials.*
- *Give preference to regional materials*

Some of the national available products and providers that comply partially or totally with the previous parameters can be seen on the following tables. For technical datasheets and additional information of the cited products see appendix 4.

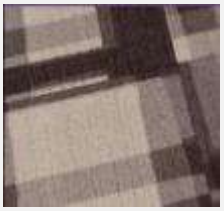
Environmentally friendly carpets providers		
	***Provider***	Intercorp Contract Resources
	Product	Milliken carpets
	Recycled content	35% recycled content (24% post industrial)
	Description	Certified by the carpet and Rug Institute's Green Label Plus. The only carpet manufacturer to achieve carbon negative status (capturing 10 times more CO2 than produced) All Milliken carpet can be renewed, reused or recycled, no carpet to landfill policy.
	***Provider***	Interfaceflor
	Product	Interface carpets
	Recycled content	Depending on the chosen product it contains up to 50% of recycled content. Convert™ products are made of type 6 or 6,6 nylon fiber and non-virgin PVC backing, featuring 64-73% total recycled content, including 32-35% post-consumer.
	Description	Low VOC emissions, complying with LEED's requirements.
	***Provider***	DuPont
	Product	DuPont Sorona Commercial carpet
	Renewable materials %	DuPont™ Sorona® contains 37% renewable sourced material derived from corn.
	Description	Sorona ® fiber contains 37% annually renewable plant based ingredients by weight (28% biobased carbon)

Table 25: Environmentally friendly carpet providers

Paint providers with low organic volatile compounds		
	***Provider***	PPG Architectural Coatings
	Product	Porter Paints : Silken Touch®, Hi-Hide® Pittsburgh Paints: Timeless®, Manor Hall Pure Performance®
	VOC content	Silken Touch, Hi-Hide Timeless and Manor Hall lines are low on VOCs, complying with LEED's requirements. Pure Performance line has Zero VOC content.
	***Provider***	Behr
	Product	Premium Plus Interior Paints & Primers Premium Plus Ultra Interior Paints
	VOC content	Low on vocs, complying with LEED's requirements.

Table 26: Low VOC paintings

Environmentally friendly wood flooring providers		
	***Provider***	Madex
	Product	FSC wood flooring Bamboo flooring
	Description	FSC certified wood flooring and FSC certified laminated wood flooring Laminated wood flooring of rapidly renewable materials
	***Provider***	Resysta
	Product	Resysta Aged Teak
	Description	Wood imitation flooring, made of rapidly renewable materials (60% rice husks, 22% common salt and 18% mineral oil)
	***Provider***	Recitec
	Product	Compuesto de fibra Plastica
	Description	Wood imitation flooring made of agricultural and plastic fibers.

Table 27: Environmentally friendly Wood flooring

Environmentally friendly ceramic tiles providers		
	Provider	Interceramic
	Product	Ceramic Flooring
	Description	Flooring tiles with recycled content, high SRI values, low VOC's, and locally manufactured. To verify the sustainable features of each product go to: http://www.interceramicgreen.com/MEX/green/productos.asp?OpcMenu=4
	Provider	Lamosa
	Product	Porcelanite Ceramic Tile
	Description	Durable ceramic tiles with incorporated recycled content. Verify the tile selection for specific recycled content.

Table 28: Environmentally friendly flooring tiles

Concrete floor finishes providers with low organic volatile compounds		
	***Provider***	CornerStone Flooring de Mexico
	Product	Polyurethane & Polymer Flooring
	VOC content	Corner*Stone* Flooring can provide low odor and low/zero VOC flooring systems with low to zero off-gassing.
	***Provider***	CureCrete
	Product	Ashford Formula
	VOC content	Containts no solvents or volatile organic compounds (VOCs). It is non-toxic, and produces no harmful fumes or vapours.

Table 29: Concrete floor finishes with low VOCs

Environmentally friendly grid ceilings		
	***Provider***	Armstrong
	Product	Tierra™
	Description	Grows from seed to harvest in just 100 days – 44% rapidly renewable material. The first Cradle to Cradle Certified℠ Silver ceiling tile Low VOC content Anti-Mold/Mildew & Bacteria
	***Provider***	USG
	Product	Mars™ Clima Plus™ Eclipse™ Clima Plus™
	Description	Available in Optimized Recycled Content formulations to help maximize LEED recycled content contribution Non-directional,monolithic visual reduces installation time and waste

Table 30: Environmentally friendly grid ceilings

Celings providers with higher recycled content			
Provider	***Product***	***Post-consumer recycled content***	***Pre-consumer recycled content***
USG-Mexico	Tablaroca	5%	36.5%
USG-USA	½" SheetRock	5%	94%
Georgia Pacific	ToughRock-USA	5%	0%
	ToughRock-CAN	5%	40%
	ToughRock-IN	6.2%	93%
American	Not Fire-Rated Plant: NM/OK/CO	6-7%	0-3%
Gypsum	Not Fire-Rated Plant: SC	6%	93%
	Fire Rated Plant:Nm/OK/CO	5%	0-3%
	1" Shaft Liner-Plant:NM/OK/CO	3%	0%
	1" Shaft Liner-Plant: SC	3%	95%
National	KS/TX/IA	5%	3%
Gypsum	NC/PA/FL	0%	95%
Temple-Inland	Regular and Waterproof	4%	93%
	Type X & C, and Fireproof	3%	90%

Table 31: Ceiling providers with higher recycled content

433 Doors and Windows

Wood

During the selection of doors and windows it should be kept in mind that all wood used or permanently installed in the project must be FSC certified, for additional information about certified wood refer to section 411.13.

Glass

To guarantee an adequate thermal performance of windows in VESTA's office buildings, glassing employed in the building should comply with the minimum requirements established on the following table.

Cancun
The window assembly (glass and frame) should have a maximum U-value of 6.814 W/m^{2}K (1.2 BTU/Ft^{2}h°F) and a maximum Solar Heat Gain Coefficient (SHGC) of 0.25.
Tijuana
The window assembly (glass and frame) should have a maximum U-value of 4.259 W/m^{2}K (0.75 BTU/Ft^{2}h°F) and a maximum Solar Heat Gain Coefficient (SHGC) of 0.25.
Queretaro
The window assembly (glass and frame) should have a maximum U-value of 3.691 W/m^{2}K (0.65 BTU/Ft^{2}h°F) and a maximum Solar Heat Gain Coefficient (SHGC) of 0.25.

Table 32: Windows requirements according to ASHRAE

Different providers can comply with the previous parameters; the contractor should verify that the chosen product complies with the desirable U-value and SHGC established on table 32. Among the providers that comply with the required parameters are Pilkington windows, the following table summarized the products that comply with both values.

Pilkington México
www.pilkington.com.mx
Calzada de la Naranja No. 154
Col. Industrial Alce Blanco
Municipio de Naucalpan de Juárez
T: 1800 561 6491

Visible light transmittance %	Solar direct transmittance %	U-value W/m^{2}K	SHGC
Exterior glassing Pilkington Solar-E™ Artic Blue Interiro glassing Energy Advantage (based on 6mm glass thickness and 12,7mm air filled cavity)			
30	15	1.7	0.24
Exterior glassing Pilkington Solar-E™ Artic Blue Interiro glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
32	15	1.5	0.23
Visible light transmittance %	**Solar direct transmittance %**	**U-value W/m^{2}K**	**SHGC**
Exterior glassing Pilkington Solar-E™ Grey Interiro glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
26	16	1.5	0.24
Exterior glassing Pilkington Solar-E™ EverGreen Interiro glassing Pilkington Energy Advantage™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
37	16	1.7	0.25
Exterior glassing Pilkington Solar-E™ EverGreen Interiro glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
40	16	1.5	0.24
Exterior glassing Pilkington Eclipse Advantage™ EverGreen Interiro glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
43	18	1.5	0.25
Exterior glassing Pilkington SuperGrey™ Interiro glassing Pilkington Energy Advantage™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
8	4	1.6	0.15
Exterior glassing Pilkington SuperGrey™ Interiro glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
7	5	1.8	0.15

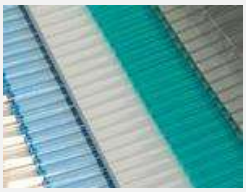
Table 33: Pilkington glassing products

If skylights are going to be used for natural illumination of the warehouses, take into consideration the following parameters.

Cancun
The skylight area should not exceed 5% of the total roof area.
Curbed skylights should have a maximum U-value of 10.788 W/m^{2}K (1.90 BTU/Ft^{2}h°F) and a maximum SHGC of .27.
Skylights without curb should have a maximum U-value of 7.722 W/m^{2}K (1.36 BTU/Ft^{2}h°F) and a maximum SHGC of .19.
Tijuana
The skylight area should not exceed 5% of the total roof area.
Curbed skylights should have a maximum U-value of 10.788 W/m^{2}K (1.90 BTU/Ft^{2}h°F) and a maximum SHGC of .34.
Skylights without curb should have a maximum U-value of 7.722 W/m^{2}K (1.36 BTU/Ft^{2}h°F) and a maximum SHGC of .19.
Queretaro
The skylight area should not exceed 5% of the total roof area.
Curbed skylights should have a maximum U-value of 7.381W/m^{2}K (1.30 BTU/Ft^{2}h°F) and a maximum SHGC of .34.
Skylights without curb should have a maximum U-value of 3.918W/m^{2}K (0.69 BTU/Ft^{2}h°F) and a maximum SHGC of .19.

Table 34: Skylights requirements according to ASHRAE

Table 35 provides information about skylights and/or polycarbonate providers with thermal insulation properties that contribute towards the achievement of values established on table 34. For further information about products mentioned in this section refer to appendix 4.



Provider	Stabilit Humberto Lobo 9317 Complejo Industrial Mitras 66000, García, N.L. Tel: (81) 8151.8300
Products	Makrolon
Thermal conductivity	8.40 W/m2K per inch

Provider	Polygal Chimalpopoca No. 54 Col. Lazaro Cardenas Naucalpan Edo. De Mex., C.P. 53560 Phone: (5255) 5359-9999 ventas@pogalmex.com.mx
Product	Thermogal
Thermal conductivity	25mm> 1.7 W/m2.°K 32mm> 1.4 W/m2.°K 35mm> 1.36 W/m2.°K

	***Provider***	Everlux S.A. de C.V. Monterrey, México Teléfono: +52 (81) 8192-0303 Fax: +52 8189 89 84 64 Sin Costo en México: 01800-614-1705
	Product	Solatube
	Thermal conductivity	Flush OptiView> 0.42W/m2.°K (0.40 SHGC) Flush Frosted> 0.42 W/m2.°K (0.40 SHGC) Curved Prismatic> 0.48W/m2.°K (0.37 SHGC)

	***Provider***	Major Industries. Post Office Box 306 Wausau, Wisconsin 54402-0306 Toll-Free: (888) 759-2678 Local: (715) 842-4616 Email: info@majorskylights.com
	Product	Guardian 275
	Thermal conductivity	No insulation> 0.48 W/m2.°K (0.52-0.24 SHGC) Insul 24> 0.20 W/m2.°K (0.24-0.15 SHGC) Insul 15> 0.17 W/m2.°K (0.22-0.14 SHGC) Img 125> 0.08 W/m2.°K (0.09-0.06 SHGC)

Table 35: Skylight providers

434 Facilities

Among the areas of opportunity identified in VESTA's building shells, is the development of a measurement and verification plan to ensure that systems are performing as designed, identifying if there are anomalies in equipment, operation procedures or user habits. Other areas of opportunity are the incorporation of efficient public lighting and renewable energy systems to decrease energy consumption.

434.1 *Measurement and Verification*

Measurement and verification (M&V) is the process of using "measurements" to determine actual savings within an energy and water efficient project. The purpose of an M&V plan is to provide accountability of the building energy and water consumption, contrasting the results to projected savings, allowing for implementation of corrective actions if the desired savings are not being achieved.

Measurement and verification should be implemented on each project to obtain better results. The M&V plan should provide a level of accuracy consistent with the needs of the project, all participants involved should perform their designated tasks at an acceptable level, savings should be anticipated within reasonable margins, savings and payments should be properly credited and accounted for, and results should be used to identify, predict, and project problems that require correction.

434.11 ***Measurement and Verification Plan***

The M&V plan is a document that defines a project specific procedures and methods for determining energy and water savings. The initial M&V plan should be developed during the project feasibility and definition stage, it is unadvisable to proceed with an energy saving project that does not have a way of measuring and verifying the savings outcomes. A final M&V plan should be prepared and submitted when details of the systems design are defined and installations are finalized.

The M&V plan must clearly define responsibilities, required abilities and training of the parties involved in the measurement and verification process, addressing at least the following issues:

- *Equipment procurement, installation and commissioning*
- *Equipment maintenance and calibration*
- *Warrantee responsibility and ownership*
- *Performance of calculations and reporting*
- *Auditing*
- *Record keeping*

The measurement and verification plan is responsibility of the maintenance manager, and should include the following information:

- *A general description of the facility*
- *People involved in measurement and verification activities:*
  - *Roles and responsibilities of the people involved*
  - *Training requirements of the people involved*
- *Description and accountability of systems to be measured*
- *Specification of metering points, periods, reading procedures, calibration processes and methods of dealing with missing or erroneous data.*
- *Monitoring and testing procedures for systems performance. This information should be automatically registered by automated systems within the facility (BAS and data loggers)*
  - *Automated systems log*
  - *Data loggers*
  - *Disposition of testing procedures*
  - *Reports outline*
- *Documentation of systems sensors*
- *Development of a plan for calibrating the equipment*
- *Expected accuracy of measurements, data capture and analysis*
- *Protocols for identifying existing systems issues and fixing procedures*
- *Annual verification reports*
  - *Summary of solved issues*
  - *Definition of the budget and resources required for measurement and verification procedures*
  - *Savings outcomes*

Appendix 5 includes a sample outline for an annual measurement and verification report. For more information about how to develop a measurement and verification plan go to http://mnv.lbl.gov/keyMnVDocs/femp.

434.2 *Electrical Facilities*

All electricity consumed within the warehouse leasable area is responsibility of the tenant. Because the energy, lighting, and electrical equipment requirements can greatly differ from one tenant to another, it is difficult to establish a sustainable criterion that unifies equipment requirements within warehouses. However, it is possible to propose sustainability parameters for exterior facilities such as exterior lighting. This section focuses on proposing efficient exterior lighting and renewable energy systems (photovoltaic panels) to increase sustainability on Vesta's properties and reduce electricity charges for tenants.

434.21 *Exterior Lighting*

Electrical facilities, particularly street lighting is an area of opportunity for the incorporation of green technologies in Vesta's building shells. Efficient street lighting design integrates efficient lamp technologies, optimum pole placement, efficient fixture photometrics (light distribution), and aesthetics while using the least amount of energy and complying with visibility and appropriate light levels requirements.

Among the benefits of efficient street lightings are:

- *Energy savings: efficient lighting fixture can reduce energy consumption.*
- *Capital cost savings: proper spacing and placement can reduce the number of fixtures needed.*
- *Maintenance cost savings: using lamps with longer lives and layouts with proper spacing and placement reduces cost for fixing burnouts and painting or replacing of damaged poles.*
- *Improved sense of security: efficient equipment and proper design can increase an area safety appearance, reducing crime rates.*
- *Evenly lit roads and sidewalks: a good lighting design can improve visibility on roads and walkways.*
- *Reduced glare and improved visibility: an adequate lighting design minimizes unwanted glare, improving visibility.*
- *Aesthetically pleasing: an adequate selection of lighting fixture can contribute to the overall appearance of the facility.*

The selected street lighting should comply with the Mexican norm NOM-013-ENER-1996 to ensure that an energy efficient product is being selected. The minimum required lamp efficacy should be 40 lm/W.

The maximum lighting power density for parking lots should be based on the following table:

Illuminated area m^2	Power density W/m^2
<300	1,80
300- 500	0,90
500-1 000	0,70
1 000-1 500	0,58
1 500-2 000	0,54
>2 000	0,52

Table 36: Electrical lighting power density for parking lots

The maximum lighting power density for streets should be:

Luxes (lx)	Street width (m)			
	7.5	9.0	10.5	12.0
3	0.26	0.23	0.19	0.17
4	0.32	0.28	0.26	0.23
5	0.35	0.33	0.30	0.28
6	0.41	0.38	0.35	0.31
7	0.49	0.45	0.42	0.37
8	0.56	0.52	0.48	0.44
9	0.64	0.59	0.54	0.50
10	0.71	0.66	0.61	0.56
11	0.79	0.74	0.67	0.62
12	0.86	0.81	0.74	0.79
13	0.94	0.87	0.80	0.75
14	1.01	0.95	0.86	0.81
15	1.06	1.00	0.93	0.87
16	1.10	1.07	0.99	0.93
17	1.17	1.12	1.03	0.97

Table 37: Electric lighting power density for streets

Besides complying with the NOM-013-ENER-1996 it is highly advisable to incorporate High Power LED street lighting, since it will contribute to reduce energy consumption within the property. LED lighting has an efficiency of 80%, meaning that 80% of energy is converted to light, while the remaining 20% is lost as heat. A typical incandescent light bulb has an efficiency of 20%, losing 80% of energy as heat. Other benefits of LED lighting are:

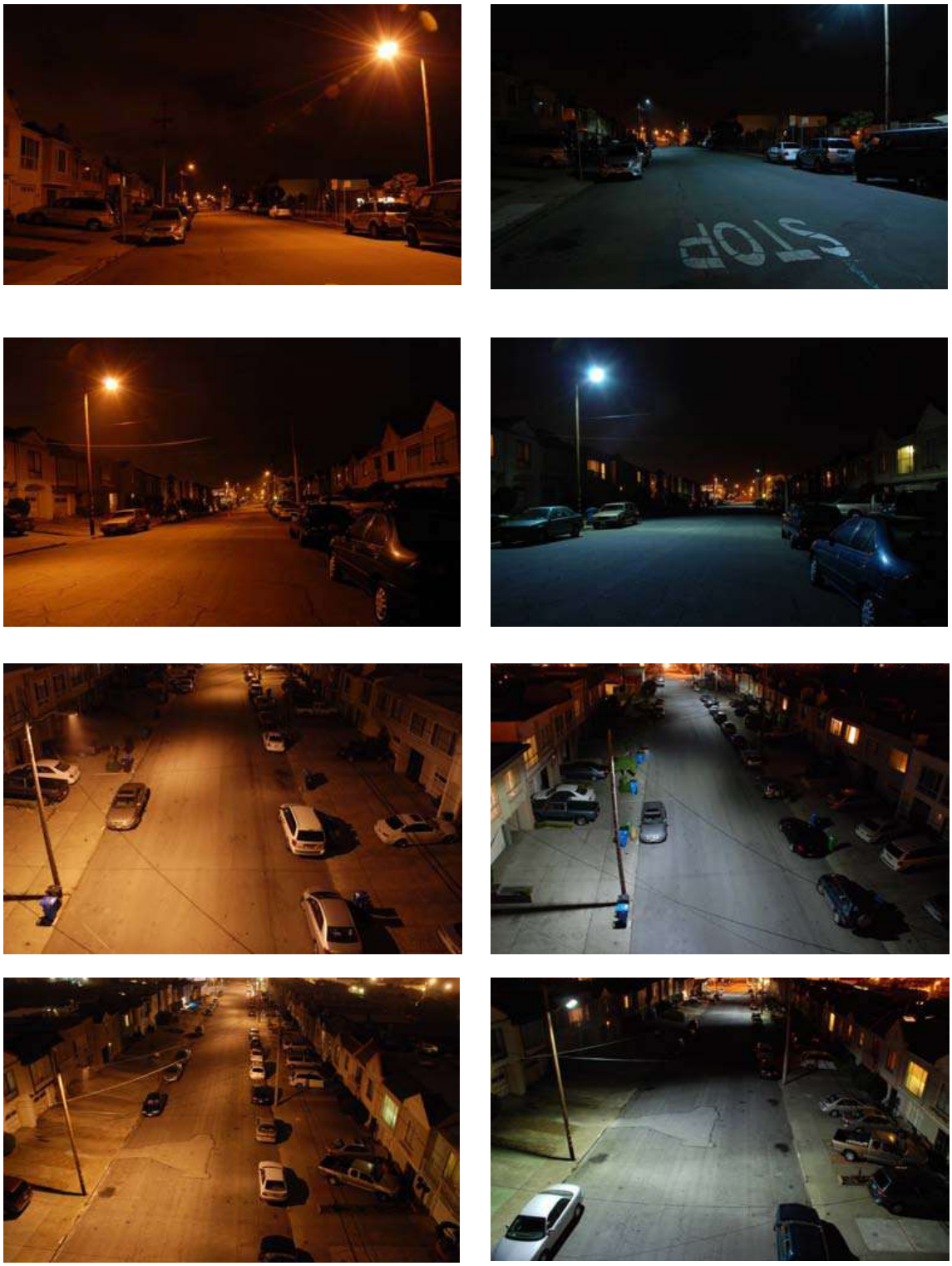
- *Increased longevity when compared to other systems.*
- *Decreased operative cost.*
- *It does not contain ultraviolet nor infrared rays.*
- *The Color Rendering Index is higher when compared to other luminaries, allowing clear lighting and true color reproduction.*
- *Minimum start up time.*
- *It does not include fragile components such as filaments, increasing its durability.*

The following chart compares LED lighting with other lighting systems:

Lighting technology	Efficacy (lm/W)	Color Rendition Index	Lifetime (hours)	Characteristics
High-pressure Mercury	36-65 lm/w	Average	10,000-15,000	High energy consumption Reduced longevity
Metal halide	70-130 lm/w	Excellent	8,000-12,000	High efficiency Reduced longevity
High-pressure Sodium	50-150 lm/w	Average	15,000-24,000	Energy efficient Poor color rendering
Low-pressure Sodium	100-190 lm/w	Very poor	18,000-24,000	Energy efficient Poor color rendering
Low-pressure Mercury Fluorescent Tubular Lamp (T12 & T8)	30-90 lm/w	Good	5,000-10,000	Reduced longevity Medium energy efficiency Only available on low wattage
Efficient Fluorescent Tubular Lamp (T5)	100-120 lm/w	Very good	15,000-20,000	Energy efficient Increased longevity Only available on low wattage
LED	70-160 lm/w	Good	40,000-90,000	Increased energy efficiency Low maintenance required Increased longevity Does not use polluting components Increased cost Still a developing technology

Table 38: street lighting technologies comparative chart

Besides producing energy savings, LED lighting have a higher color rendering index than traditional high pressure sodium fixture, as can be seen on the images below.



High Pressure Sodium Lighting LED Lighting

Figure 66:Comparative images of High Presure Sodium Lighting and LEDs (Source: PGEC, 2008)

A study conducted by the School of Swanson during 2010 compared the street lighting fixture most commonly used (High-pressure Sodium and High-pressure Mercury) with LED luminaries, resulting in life cycle savings of 53.5% compared to high-pressure sodium lamps and 74.8% compared to high-pressure mercury lamps.

New lighting fixture performance	High pressure Sodium	LED	High pressure Mercury	LED
Efficacy (lm/W)	120	72	65	72
Lamp efficiency	0.595	0.72	0.595	0.72
Average lighting efficiency (W/lm)	0.035	0.023	0.065	0.023
Energy savings	-	35.4%	-	65.0%
Life cycle performance	0.7	0.8	0.7	0.8
Maintenance factor	0.4	0.7	0.4	0.7
Luminance decay	3	10	3	10
Life cycle - years	0.7	0.85	0.7	0.85
Life cycle – average luminance decay	14.0	30.1	7.6	30.1
Life cycle – average lamp efficiency	0.071	0.033	0.132	0.033
Life cycle – energy savings	-	53.5%	-	74.8%

Table 39: LED lighting savings when compared with other lighting systems

Table 40 provides contact information for some well acknowledged LED street lighting national providers.

Philips Mexicana S.A. de C.V.
Av. De la Palma No 6, Col. San Fernando La Herradura
52784. Huixquilucan, Edo. de México
http://www.lighting.philips.com.mx/connect/index.wpd

MetroLed
Av. Humberto Lobo No. 520, Local K-02
Plaza San Pedro 52.81.8378.3810
http://metroled.mx/catalogo/urbanas/

Kolben
Monterrey 52.81.8379.9941
01-800-900-8889
http://www.kolbentech.com/

Table 40: LED lighting providers

434.3 *Renewable Energy Systems*

Renewable energy systems derive their energy from existing flows of energy, from on-going natural processes such as sunshine, wind, flowing water, biological processes, and geothermal heat flow, as opposed to single-use fossil fuels such as coal or oil.

Fossil fuels pollute water and air, have negative impacts on plants and animal life, create toxic waste, and cause global warming. Nuclear fuels on the other side poses serious safety risk implications. Renewable energy avoids most of this environmental impacts and risks, and contributes to the conservation of fossil fuels for future generations.

The most common forms of alternative energy currently available are solar power, wind power and micro-hydro power. The use of one source over the others will depend on the natural resources available, and the specific weather conditions on the site.

In order to comply with international standards, such as LEED Core & Shell, it is highly advisable that Vesta's Industrial Parks use renewable energy sources to provide for at least 1% of its total energy consumption. Because there is not an average energy consumption between warehouses (it will vary depending on the activities of the leasing company), the renewable energy systems proposed on this handbook will focus on providing electricity for exterior lighting, which is similar among warehouses.

434.31 ***Photovoltaic systems***

Solar power is one of the most promising renewable energy sources in the world, it is non-polluting, requires little maintenance, PV panels have a light span of over 20 years and a relatively short return of investment. Therefore, it is advisable to install photovoltaic systems in VESTA's warehouses to provide energy for exterior lighting.

There are different ways to integrate photovoltaics into street lighting systems, the most commonly used alternatives are:

- *Photovoltaic street lighting systems*
- *Grid-connected photovoltaic power systems.*

Photovoltaic street lighting systems

Photovoltaic or solar street lights are powered by photovoltaic panels that charge a rechargeable battery used to provide energy to the lamp. Most solar street lights include an outdoor sensor to turn on and off automatically depending on the natural lighting levels. Nowadays, solar street lighting systems can function without sunny conditions for a couple of days, but street light hybrid systems are becoming increasingly popular to guarantee an adequate performance of the luminary during the winter time or cloudy seasons.

Figure 67: Photovoltaic lighting systems

Hybrid street lighting systems are designed to be self sufficient but climate data such as average monthly sunshine and wind speed of the specific site location needs to be considered. In Mexico, there is an average of five peak monthly sunshine hours, but the wind speed changes widely depending on the specific site location and its topography. More information regarding wind speed can be found on the national meteorological service website http://smn.cna.gob.mx.

The usual startup wind speed of turbines used for hybrid street lighting is 2 meter per second, this need to be contrasted with the average wind speed of the site. The turbine and solar panel combined should provide enough energy for the battery backup of a 2 to 3 day - 10 to 12 hour cycle.

Street light powered by photovoltaic panels must be tilted 30º in the northern, 25º in central zones, and 20º in the southern part of the country. The panels array must always be facing south, and shadows must be avoided since it considerably decreases the panel efficiency. It is advisable that the solar street lighting provider conducts a shading study to guarantee an adequate performance of the system. Moreover, LED lamps should be use in solar street lighting to increase the efficiency of the system.

Figure 66 describe the components and functioning (electrical connection scheme) of the street lighting hybrid systems.

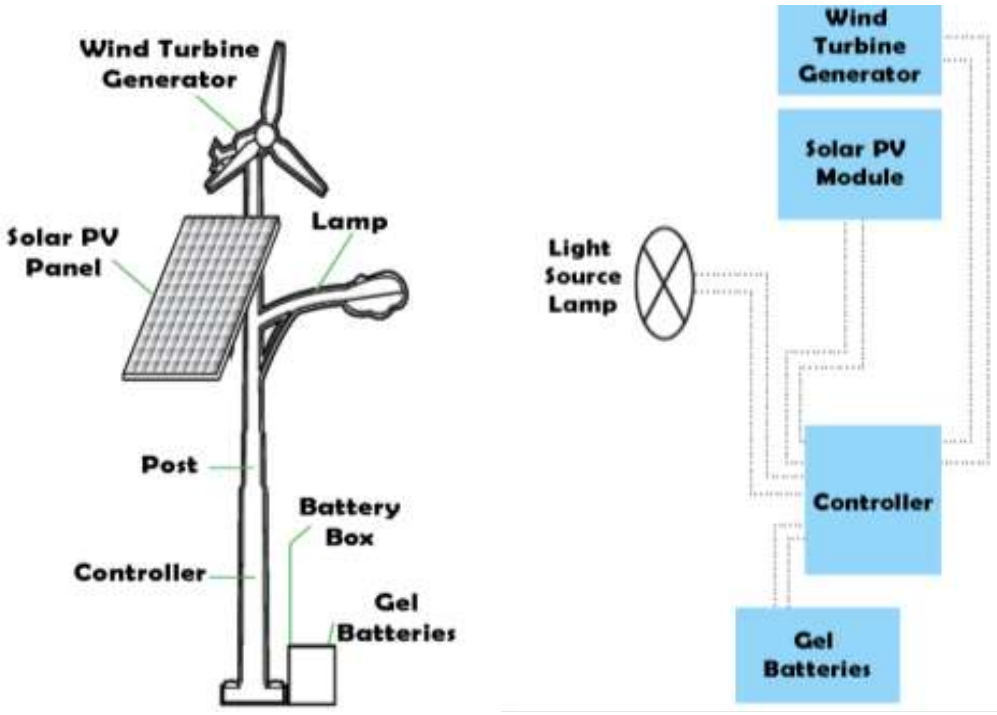


Figure 68: Hybrid street lighting system diagram

Table 41 provides contact information for suppliers of photovoltaic and hybrid street lighting systems in Mexico. For further information about their products refer to appendix 6.

Photovoltaic Street Lighting Systems	
Grupo Ecos Chilpa #69 Col. Santa María Nonoalco Delegación Álvaro Obregón, México D.F. T. (5255) 5667 51 55 F. (5255) 5667 52 48 *info@eco-sistemas.com.mx* *www.grupoecos.com.mx*	
Hybrid Street Lighting Systems	
Bioconstrucción y Energía Alternativa Río Mississippi 347 Ote. Col. Del Valle, San Pedro Garza García, N.L. T. (5281) 8040 80 80 *ventas@bioconstrucción.com.mx* *carriaga@bioconstrucción.com.mx*	

Table 41: Hybrid lighting systmem provider

Grid-connected photovoltaic power systems

Grid-connected photovoltaic power systems are an alternative to solar street lighting. It differs from standalone systems because it does not require batteries to store the energy produced. If this system is employed, a precalculated number of photovoltaic panels should be installed on the warehouse's roof, so that the type and number of panels provide enough electricity to satisfy exterior lighting needs. If in a particular moment more power is produced than required, the extra power will be sent (sell) to the grid, the feedback is done through a meter to monitor the amount of power transferred. The electricity send to the grid will produce savings for tenants, since the cost of electricity generated by the PV panels will be deducted from the cost of electricity consumed.

It is advisable to install a sub-meter to verify that the photovoltaic array is meeting the required lighting energy demand, and to differentiate the warehouse street lighting consumption from the warehouses general energy consumption.

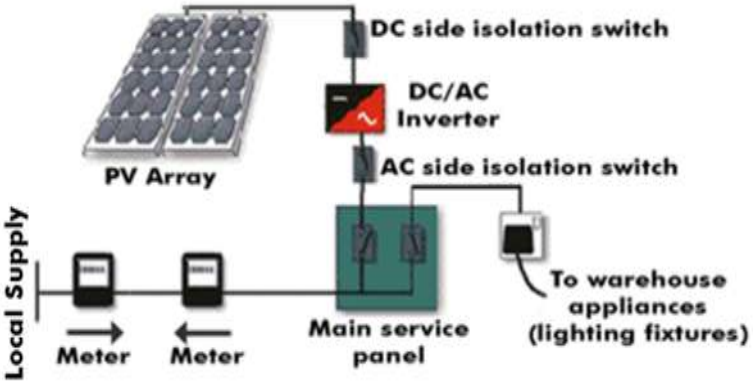


Figure 69: Grid-connected photovoltaic power system diagram

The typical grid-connected photovoltaic power system components are:

PV Array	Is made of PV modules, which are environmentally sealed collection of PV Cells (where conversion of sunlight to electricity takes place).
Balance of system equipment (BOS)	BOS includes mounting and wiring systems used to integrate the PV modules into the structural and electrical systems of the home. The wiring systems include disconnects for the dc and ac sides of the inverter, ground-fault protection, and overcurrent protection for the solar modules.
DC/AC Inverter	This device takes the DC power from the PV array and converts it into standard AC power used by the house appliances.
Metering	Used to provide indication of system performance. Some meters can indicate home energy usage.

Table 42: Grid-connected photovoltaic system components

The analysis of current lighting fixtures was considered for the calculations of photovoltaic panels needed to provide electricity for VESTA's warehouse exterior lighting, considering the basecase scenario. The following table summarizes the analysis made to implement photovoltaic panels to provide energy for exterior lighting on VESTA's industrial shells.

Industrial park photovoltaic system requirements	
Requirements to produce energy for all exterior lighting consumption	
Required power (keeping existing lighting fixtures)	41 kW
Required power (upgrading existing lighting fixtures)	18 kW
Module type	Policrystaline
Module Power Capacity	230 W
Number of modules required	178> if current lamps are used 78> if LED lamps are used
Total cost of the system installed	$184,500> if current lamps are used $81,000> if LED lamps are used
Requirements to produce energy for middle and peak exterior lighting consumption	
Required power (keeping existing lighting fixtures)	16 kW
Required power (upgrading existing lighting fixtures)	7 kW
Module type	Policrystaline
Module Power Capacity	230 W
Number of modules required	69> if current lamps are used 30> if LED lamps are used
Total cost of the system installed	$72,000> if current lamps are used $31,500> if LED lamps are used
Requirements to produce energy for peak exterior lighting consumption	
Required power (keeping existing lighting fixtures)	7 kW
Required power (upgrading existing lighting fixtures)	3 kW
Module type	Policrystaline
Module Power Capacity	230 W
Number of modules required	69> if current lamps are used 30> if LED lamps are used
Total cost of the system installed	$31,500> if current lamps are used $13,500> if LED lamps are used

Table 43: Warehouse photovoltaic panels' proposal

The photovoltaic panel considered for the solar field array at VESTA Industrial Shells can be seen on the following table. For further details about the panel go to appendix 6.

Proposed PV panel – electrical specifications		
	Provider	Bioconstrucción y Energía Alternativa S.A. de C.V.
	Product	Xtp60_60 photovoltaic panel
	Features	High module conversión efficiency Positive tolerance Slendid appearance Low PID rate Smart auto-recognition of weak light performance Steady resistance to strong hailstone, wind and snow loads Shinetime sorting standards Certified manufacturing facility

Table 44: Proposed PV panels

For further information about the initial investment cost of renewable energy system, and the payback period of such systems refer to section 500.

435 Public facilities

To comply with international sustainability standards public facilities such as bicycle racks and a waste center for the collection of recyclables should be included in the facility.

- *Secure bicycle storage should be provided for 5% or more of regular building occupants to promote the use of alternative transportation. The bicycle racks should be located within 180 meters from the building main entrance. Changing rooms should also be provided for those employees arriving by bicycle.*

Figure 70: Secure bicycle racks should be provided for employees.

- *A waste center for the collection of recyclables should be provided to divert the facility's waste from landfills. The waste center should provide separate containers for paper, cardboard, glass, plastic, metals.*

Figure 71: Separate paper, cardboard, glass, plastic and metal containers should be provided.

440 Commissioning Plan

Building commissioning is the process of verifying, that all the subsystems for HVAC, plumbing, electrical, fire/life safety, building envelopes, interior systems, cogeneration, utility plants, sustainable systems, lighting, wastewater, controls, and building security are installed and performed according to design.

The Commissioning Plan is the master planning, management and communications tool relating to commissioning. It specifies the process and methodology for successful commissioning of the project. The objective of the commissioning plan is to provide a fully functional facility whose systems, equipment and components have been proven to meet all Client's functional requirements, and operates consistently at peak efficiencies and within specified energy budgets under normal loads. The commissioning plan also intends to provide fully trained personnel for the operation and maintenance of the systems.

Among the benefits of developing a Commissioning Plan are reducing construction expenses and potential delays, fewer warranty claims and call backs, operational energy savings, consistently reliable systems operations, enhanced building productivity, extended service life of components, reduction of future maintenance activity and costs.

Commissioning process activities must be completed at least for the following energy-related systems:

- *Heating, ventilating, air conditioning and refrigeration (HVAC&R) systems and associated controls*
- *Lighting and daylight controls*
- *Domestic hot water systems*
- *Renewable energy systems*

A commissioning plan can usually be divided into design phase, construction phase, acceptance phase and occupancy or post-acceptance phase. The following table summarizes the main activities to consider during each phase. For a sample outline of a commissioning plan refer to appendix 7.

Design Phase
Review of design development submittals.
Commissioning specifications are created and incorporated into tender documents.
Review of construction tender documents.
Construction Phase
Commissioning scope meeting held.
Contractor submits Commissioning Plan.
Drawing submittals are reviewed in parallel by consultants and review team members.
Commissioning meetings are scheduled with consultants and/or contractors as required.
Commissioning Equipment Forms submitted and reviewed.
Commissioning Installation Forms submitted and reviewed.

Project Operation & Maintenance manuals and as-built drawings submitted and reviewed.
Functional Performance Testing.
Commissioning Performance Forms submitted and reviewed.
Integrated Systems Review
Acceptance Phase
Project turnover meeting - Construction Management to Facilities Management.
Training and orientation of personnel is scheduled and conducted.
Systems are formally accepted and warranty period begins.
Finalized Commissioning Plan documents turned over to owner.
Consultant / Contractor performance reviews completed.
Occupancy Phase
Off-season functional testing is scheduled and performed.
Preventative maintenance work orders are added.
Managers coordinate any remaining warranty work.
Re-commissioning is schedule.

Table 45: Commissioning Plan activities by phase

500 RETURN ON INVESTMENT ANALYSIS

A Return on Investment (ROI) analysis for the main eco-technologies proposed on this Handbook was conducted to evaluate the financial consequences and payback period of integrating such technologies on VESTA's industrial properties. This section provides further information about the ROI for main eco-technologies proposed for VESTA's Industrial Shells. For information related to ROI of eco-technologies proposed for VESTA's Industrial Parks facilities and Office Buildings refer to VESTA's Sustainable Construction Handbook: Industrial Parks.

510 Thermal Insulation

Sustainable buildings are usually associated with higher investment cost, because they involve the use of methodologies and technologies that are not common practice. Although there are many studies about the over cost of sustainable certification on buildings, there is little data focused on Mexico. However, it is estimated that the over cost for current sustainable projects in Mexico is equivalent to that of sustainable projects in the United States seven years ago. The difference in cost between countries is due to the fact that the sustainability market has trigger in USA in later years, resulting in reduced construction costs. The following figure shows additional investment cost for LEED certify building.

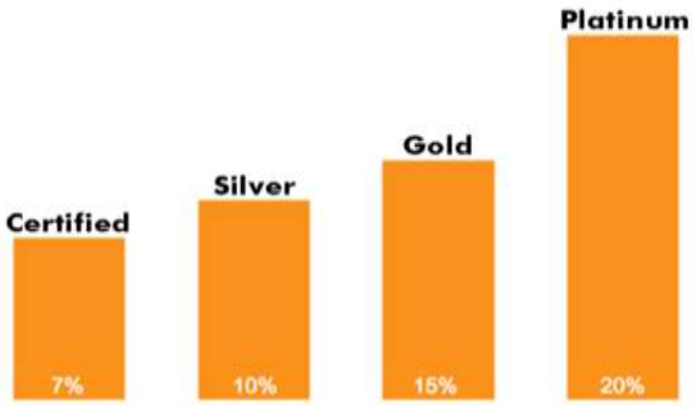


Figure 72: Additional cost for LEED certified buildings in Mexico

Although sustainable buildings require additional investment during the construction of the project, the sustainability measures employed will contribute to reduce energy consumption, operation and maintenance cost, and to increase productivity.

In the case of VESTA's Building Shells it is hard to determine a Return on Investment for Thermal Insulation due to the fact that thermal loads (lighting requirements, number of employees, conditioned spaces, process loads) within each shell can have great variations, making it difficult to predict the amount of energy saved due to building envelope properties.

A preliminary study was made to determine the impact of implementing thermal insulation on the basecase shell. This analysis consisted in a thermal load analysis of current VESTA's envelope and a shell with increased insulation, considering Tijuana climate. Increased insulation consisted on the implementation of thermally insulated skylights (guardian 270), increased wall insulation (suggested pinkcore system for walls), and thermally efficient windows (Pinkington glazing with 1.5 W/m^2K). The analysis considered a building shell without considerable process loads, with lighting loads according to ASHRAE 90.1-2007 (0.8 W/ft^2), and an average occupancy of 200 ft^2/person (based on standard values for warehouses). The following table indicates the result of the analysis.

	Yearly thermal loads (Btu/h)	HVAC Required TR (Tons of Refrigeration)
Basecase	26,337,570	2,341.5
Insulated shell	12,625,000	1,125.6

Table 46: Energy consumption between basecase building and thermally insulated shell

As shown on table 46, the thermal loads of the basecase building almost doubles the amount of the insulated shell, doubling the tons of refrigeration required to condition the building shell (considering all the building is conditioned). However, we must consider that this is representative of only one scenario, as mentioned, interior thermal loads (plugged loads, and occupation inside the building) will affect energy consumption, and it is highly possible that not all of the warehouse area is conditioned, resulting in different amounts of energy saving for each particular scenario and/or tenant.

If well, it is noticeable that thermal insulation on building shells will produce energy savings, each tenant is responsible for the payment of electricity within its own shell, and it would be the tenant and not VESTA the one receiving the benefits of thermal insulation. However, a survey conducted by CoreNet for Jones Lang LaSalle in 2005, indicated that sustainable buildings are more likely to increase its occupancy and rental rates.

Figure 73: Economical benefits of sustainable buildings

520 Renewable Energy Systems

The ROI for lighting on VESTA's Industrial Shells is based on the additional investment it would require VESTA to update its lighting fixtures to LEDs. Table 47 shows typical acquisition and installation cost for current lamps (upper part of the chart) and LED street lighting (bottom part of the chart). All prices are in dollars ($1 dollar = $13 MNX).

Quantity	*Lamp*	*Unit Price (USD)*	*Total (USD)*
38	Wallpack Metal Halide	$ 26.90	$ 1023.00
8	Vapor Sodium	$ 32.30	$ 258.50
8	Ballast	$ 140.00	$ 1120.00
	Total		$ 2401.50

Quantity	*Lamp*	*Unit Price (USD)*	*Total (USD)*
38	LED lamps (no ballast)	$ 366.15	$ 13913.85
8	LED lamps (no ballast)	$ 430.75	$ 3446.15

Table 47: LED luminaries vs. sodium vapor lamps

Table 48 shows the life cycle analysis of LEDs and sodium Vapor Lamps considering typical operation schedules during the year. As it can be seen LED lamps have an average life cycle of 50,000 hours (approximately 12.5 years), while the current lighting system has an average life cycle of 20,000 hours (approximately 5 years), meaning it would take 2.5 replacement of the current system for each replacement of LED street lighting. On table 49, the life cycle cost of the current system is shown. If initial investment and replacements cost of the current system is considered it would take only 1.8 years for the payback of upgrading the system to LEDs.

Life Cycle Analysis				
Lamp	*Life*	*Hr/year*	*Years*	*Replacements during life*
LED	50,000	4,004	12.5	0
WallPack + Streetlight	20,000	4,004	5.0	2.5

Table 48: Life cycle analysis for LED luminaries

Life Cycle Cost			
Lamp	*Lamp + Ballast*	*Replacement*	*Currency*
WallPack + Streetlight	$ 2401.50	$ 2557.70	USD
LED (no ballast)	$ 13913.85	$ -	USD
Additional Investment in LED Technology		$ 11512.30	USD
Yearly Savings	*USD*		
Energy savings		$	4647.85
O&M		$	512.05
Ballast		$	1120.00
Total		$	6279.90
ROI	*1.8 years*		

Table 49: ROI for LED luminaries

The ROI considered a typical night schedule for street lighting use, during the summer and winter time to calculate energy consumption (kWh). An HM (medium voltage) rate was considered for the analysis. Table 50 shows monthly energy consumption for lighting on VESTA's industrial parks, considering 290W Wallpacks. Table 51 shows energy consumption for VESTA's industrial park in case current street lighting gets substituted by more efficient lighting fixtures (180W LEDs luminaries). Electricity consumed during based, middle and peak time was considered for both analyses.

Month	Power (kW)	290 W Wallpack (lamp with ballast) + 464 Sodium vapor light			
		Base	Middle	Peak	Total
Jan	16	3,136	1,152	640	4,928
Feb	16	3,136	1,152	640	4,928
Mar	16	3,920	1,440	800	6,160
Apr	16	3,136	1,152	640	4,928
May	16	3,920	1,440	1,360	6,720
Jun	16	3,136	1,152	1,088	5,376
Jul	16	3,136	1,152	1,088	5,376
Ago	16	3,920	1,440	1,360	6,720
Sep	16	3,136	1,152	1,088	5,376
Oct	16	3,136	1,152	1,088	5,376
Nov	16	3,920	1,440	800	6,160
Dec	16	3,136	1,152	640	4,928
Total		40,768	14,976	11,232	66,976

Table 50: Energy consumption with current lighting system on VESTA's shell.

Month	Power (kWh)	LED Lamp Energy Consumption			
		Base	Middle	Peak	Total
Jan	7	1,960	720	400	3,080
Feb	7	1,960	720	400	3,080
Mar	7	2,450	900	500	3,850
Apr	7	1,960	720	400	3,080
May	7	2,450	900	850	4,200
Jun	7	1,960	720	680	3,360
Jul	7	1,960	720	680	3,360
Ago	7	2,450	900	850	4,200
Sep	7	1,960	720	680	3,360
Oct	7	1,960	720	680	3,360
Nov	7	2,450	900	500	3,850
Dec	7	1,960	720	400	3,080
Total		25,480	9,360	7,020	41,860

Table 51: Energy consumption for LED street lighting on VESTA's industrial shell

Table 52 illustrates electricity monthly cost according to consumed power (kW) and time-of-use (base, middle and peak), considering an HM (medium voltage) rate.

Month	$/kWh			$/kW
	Base	Middle	Peak	Power
Jan	0.064	0.078	0.134	12.742
Feb	0.065	0.079	0.135	12.818
Mar	0.067	0.082	0.138	12.873
Apr	0.070	0.085	0.142	12.915
May	0.071	0.086	0.143	12.865
Jun	0.069	0.084	0.141	12.899
Jul	0.070	0.086	0.143	12.922
Ago	0.072	0.088	0.145	12.952
Sep	0.072	0.087	0.145	12.982
Oct	0.076	0.093	0.150	13.012
Nov	0.075	0.092	0.150	13.042
Dec	0.076	0.093	0.152	13.072

Table 52: Electric cost by month (considering exterior lighting)

According to the previous information, three different scenarios were considered to calculate the ROI:

1. ***All:*** *This scenario considers that all energy consumed for street lighting in VESTA's Industrial Shell is produced through PV panels.*
2. ***Middle + Peak:*** *This scenario considers that energy produced through renewable energy systems will be used to satisfy street lighting demand during peak and middle time (the higher cost electricity rates).*
3. ***Peak:*** *This scenario considers that PV panels will only satisfy the electricity demand for street lighting during peak time.*

In accordance to the previous scenarios, and taking into consideration energy consumption shown on tables 50 and 51, the required PV panels were calculated. Table 53 show photovoltaic panels requirements considering the three scenarios for the current lightings system and if luminaries are upgraded to LEDs. As can be seen on the table if current luminaries (wallpack + streetlight) are kept the required number of PV panels will be considerably higher than if luminaries are replaced by LEDs, due to the amount of energy savings of LED lamps.

Energy Generation Scenarios						
Scenario	**Energy Consumption**	**Percentage Produced with solar modules**	**Power required**	**Modules required**	**Minimum area requirement**	**Percentage of total area available**
All	kWh	kWh	kW	modules	m2	m2
Wallpack + Streetlight	66,976	100%	41	178	350	0.37%
LED	29,302	100%	18	78	153	0.16%
Middle+Peak						
Wallpack + Streetlight	26,208	39%	16	69	136	0.14%
LED	11,466	39%	7	30	59	0.06%
Peak						
Wallpack + Streetlight	11,232	17%	7	30	59	0.06%
LED	4,914	17%	3	13	26	0.03%

Available area	95,000	m2	Warehouse rooftop

Table 53: Energy generation scenarios

The ROI for the three scenarios considering sodium vapor and LED lighting fixtures was calculated. Table 54 shows ROI for PV panels in case current lighting fixtures are considered (sodium vapor lamps and wallpacks). The first part of the table shows the initial investment, in PV panels, to satisfy energy demand for the three scenarios. The middle part of the table indicates annual operation cost for the shell's street lighting. The bottom part of table 54 shows operation cost for lighting if PV panels were installed (results for the three scenarios are included). According to the calculations the payback period for the PV panels are 19, 17 and 15 years depending on the scenario (if PV panels are installed to satisfy all energy consumption, energy consumed during the middle and peak period, or only during peak time). Additionally a Net Present Value (NPV) analysis was developed, indicating savings in energy consumption, after reaching the return of investment for the PV panels, considering a life cycle of 25years for the PVs.

Scenario	***Modules***	***Power***	***Initial Investment (USD)***
All	178	41	$ 184,500
Middle+Peak	69	16	$ 72,000
Peak	30	7	$ 31,500

WallPack + Streetlight	MXN	USD
Annual energy expenses	$ 107,417	$ 8,262.84

	MXN		USD		ROI	ROI	NPV (USD)
Scenario	with solar modules	Savings	with solar modules	Savings	Years	Rate	
All	$ 30,646	$ 76,771	$ 2,357	$ 5,905	19	7.58%	$ 123,365
Middle+Peak	$ 68,077	$ 39,340	$ 5,237	$ 3,026	17	8.54%	$ 60,372
Peak	$ 84,862	$ 22,555	$ 6,528	$ 1,735	15	8.57%	$ 23,051

Table 54: ROI Analysis considering wallpacks and sodium vapor lamps

Table 55 shows the ROI results in case LED luminaries are considered.

Scenario	Modules	Power	Initial Investment
All	78	18	$ 81,000
Middle+Peak	30	7	$ 31,500
Peak	13	3	$ 13,500

LED lamps	MXN	USD
Annual energy expenses	$ 46,995	$ 3,614.99

	MXN		USD		ROI	ROI	NPV (USD)
Scenario	with solar modules	Savings	with solar modules	Savings	Years	Rate	
All	$ 13,408	$ 33,587	$ 1,031	$ 2,584	19	7.52%	$ 53,132
Middle+Peak	$ 29,784	$ 17,211	$ 2,291	$ 1,324	17	8.54%	$ 26,413
Peak	$ 37,127	$ 9,868	$ 2,856	$ 759	15	8.75%	$ 10,328

Table 55: ROI Analysis considering LED luminaries

600 CONCLUSIONS:

This handbook is meant to contribute to incorporate sustainability principles in VESTA's industrial properties with the purpose of reinforcing the company's commitment with the environment and society, contributing to strengthen the company's image before investor, strategic partners and potential clients.

As previously detailed on the methodology section, this handbook was developed following world renowned sustainability standards (LEED™ Core & Shell 2009 Certification, and standards established by institutions mentioned in the LEED™ Reference Guide for Green Building Design and Construction, such as ASHRAE or EPA), which in addition to the analysis of case studies and current VESTA's properties, resulted in the identification of opportunity areas for the development and implementation of sustainability strategies for VESTA's Industrial Shells.

The sustainability strategies covered on this handbook focus on the development of best practices for the selection and development of the site, best practices for the achievement of energy efficiency, best practices for the selection and management of materials and resources, development of a commissioning plan to verify that the project's energy-related systems are installed, calibrated and perform as designed.

Although each project will have to be individually evaluated to see if it can reach LEED certification, the implementation of the principles established on this guide will contribute towards the achievement of LEED credits in all of its main categories. The following table summarizes the LEED credits that are covered on this guide:

Sustainable Sites		**Address on the handbook**
Prereq 1	Construction Activity Pollution Prevention	*
Credit 1	Site Selection	*
Credit 2	Development Density and Community Connectivity	*
Credit 3	Brownfield Redevelopment	
Credit 4.1	Alternative Transportation—Public Transportation Access	*
Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	*
Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	
Credit 4.4	Alternative Transportation—Parking Capacity	
Credit 5.1	Site Development—Protect or Restore Habitat	*
Credit 5.2	Site Development—Maximize Open Space	*
Credit 6.1	Stormwater Design—Quantity Control	*
Credit 6.2	Stormwater Design—Quality Control	*
Credit 7.1	Heat Island Effect—Non-roof	*
Credit 7.2	Heat Island Effect—Roof	*
Credit 8	Light Pollution Reduction	

Credit 9	Tenant Design and Construction Guidelines	
Water Efficiency		
Prereq 1	Water Use Reduction—20% Reduction	
Credit 1	Water Efficient Landscaping	*
Credit 2	Innovative Wastewater Technologies	
Credit 3	Water Use Reduction	
Energy and Atmosphere		
Prereq 1	Fundamental Commissioning of Building Energy Systems	*
Prereq 2	Minimum Energy Performance	*
Prereq 3	Fundamental Refrigerant Management	*
Credit 1	Optimize Energy Performance	*
Credit 2	On-Site Renewable Energy	*
Credit 3	Enhanced Commissioning	
Credit 4	Enhanced Refrigerant Management	
Credit 5.1	Measurement and Verification—Base Building	*
Credit 5.2	Measurement and Verification—Tenant Sub-metering	
Credit 6	Green Power	
Material and Resources		
Prereq 1	Storage and Collection of Recyclables	*
Credit 1	Building Reuse—Maintain Existing Walls, Floors, and Roof	
Credit 2	Construction Waste Management	*
Credit 3	Materials Reuse	
Credit 4	Recycled Content	*
Credit 5	Regional Materials	*
Credit 6	Certified Wood	*
Indoor Environmental Quality		
Prereq 1	Minimum Indoor Air Quality Performance	
Prereq 2	Environmental Tobacco Smoke (ETS) Control	*
Credit 1	Outdoor Air Delivery Monitoring	
Credit 2	Increased Ventilation	
Credit 3	Construction Indoor Air Quality Management Plan—During Construction	*
Credit 4.1 – 4.4	Low-Emitting Materials	*
Credit 5	Indoor Chemical and Pollutant Source Control	
Credit 6	Controllability of Systems—Thermal Comfort	
Credit 7	Thermal Comfort—Design	
Credit 8.1	Daylight and Views—Daylight	*
Credit 8.2	Daylight and Views—Views	*

Table 56: LEED credits covered on this handbook

610 Sustainability Checklist:

The following checklist intents to provide a guideline to verify that sustainability principles and strategies provided on this Handbook for VESTA's Building Shells are being met. In case of a negative answer refer to the corresponding section of this Handbook, double-check the reason why the proposed strategy was not applied, and proceed to corrective measures if applicable.

Preliminaries		
	Yes	No
1. Was an Owners Project Requirement document developed in the beginning of the project? (Section 210)		
Sustainable sites		
2. Was the development of an industrial park avoided on prime farmland, sites with an elevation lower than 1.5 meters above the elevation of the hundredth year flood, land identified as habitat for endangered species, land within 30 meter of wetlands, land within 15 meter of water bodies, land that used to be public parkland? (Section 311)		
3. During the site selection phase, was preference given to sites within an existing urban fabric? (Section312)		
4. Is public transportation accessible for personnel of the Industrial parks? (Section 313)		
5. Were strategies to promote alternative transportation such as preferred parking and bicycle racks considered? (Section 313)		
6. Is open space equal to 20% of the Industrial Park gross area? (Section 314)		
7. Were materials that contribute to minimize the heat island effect chosen (e.g. materials with high SRI, green roofs, etc.)? (Section 314, 431.41)		
8. Are stormwater quantity and quality control strategies being implemented on the facility? (Section 315)		
9. Was an erosion and sedimentation plan developed before construction? (Section 421)		
10. Was a habitat protection plan developed during the design phase? (Section 422)		
Indoor environmental quality		
11. Is smoking inside the building and within eight meters of entries, air intakes and operable windows prohibited? (Section 321)		
12. Were the following strategies to minimize exposure of building occupants to potentially hazardous pollutants considered: installation of permanent entryway track-off systems, containment drains to control hazardous liquids, MERV 13 filters? (Section 322)		
13. Were daylight strategies considered during the design phase of the buildings? (Section 323)		
14. Have building occupants accessibility to exterior views?		

(Section 324)

15. Was a construction indoor air quality management plan developed before construction started? (Section 423)

Materials

16. Are at least 10% of products and materials used in the construction of the buildings regionally extracted (within an 800 kilometer radius)? (Section 411.11)
17. Do at least 10% of materials used for construction incorporate recycle content? (Section 411.12, 431.1)
18. Are wood-based materials FSC certified? (Section 411.13)
19. Were VOC limits considered during the selection of interior finishes? (Section 411.2, 432)
20. Was a construction waste management plan developed before construction started? (Section 424)
21. Is a waste center for the collection of recyclables considered in the project (Section 435)

Energy

22. Was adequate thermal insulation procured during the selection of materials and finishes for the building envelope? (Section 411.3, 431, 433)
23. Was a measurement and verification plan developed? (Section 434.1)
24. Were LEDs luminaries considered for street lighting? (434.21)
25. Were photovoltaic systems installed on the warehouses? Do they follow the recommendations established on section 434.3 to guarantee sufficient energy for exterior lighting?
26. Was a commissioning plan developed to verify that equipment and systems will perform as designed? (Section 440)

Water

27. Was native vegetation that contributes to reduce water irrigation requirements considered? (Section 431.42)
28. Were green roof considered for office buildings to minimize stormwater runoff? (section 431.42)

620 Shell Sustainability Summary:

The measures included in VESTA's Sustainable Construction Handbook provide a framework to incorporate sustainable construction practices on VESTA's real estate properties. The recommendations included on this guide can be classified into following categories:

Sustainable Sites
Measures to reduce pollution and control site disturbance, such as the implementation of an erosion and sedimentation plan, the use of permeable paving, and other sustainable materials on exteriors, are to be implemented on VESTA's new developments; protecting habitats, existing site resources and contributing to reduce the heat island effect.

Water Efficiency
Water saving fixtures are to be installed on buildings and gardens. Additionally native or adaptive plants will be selected for landscape design to minimize water requirements. Wastewater will be treated on site to reduce potable water use. Rainwater will be harvested for reuse, and to minimize pollution of nearby rivers and water bodies.

Energy and Atmosphere
The insulation of current shells will be improved to increase thermal comfort within the buildings, and to reduce HVAC systems energy requirements. Additionally, exterior lighting will be upgraded to LED luminaries reducing the shell's operation cost. Photovoltaic panels are also recommended to achieve further energy savings and reduce dependency on fossil fuels.

Material and Resources
Regional, recycled and green materials will be incorporated in the project to reduce the building environmental impact, and to contribute to the economical development of the place. Storage for recyclables will be included in the project to incentivize recycling among employees and visitors.

Indoor Environmental Quality
Special attention will be given to finishes, reducing the amount of volatile organic compounds that affects the employees' health and productivity. Accessibility to daylight and natural views will be procured to generate healthier environments. Increased insulation will be installed for the envelope to increase thermal comfort of occupants. Measures to reduce exposure to tobacco smoke will be taken to improve air quality of buildings.

Compared to the basecase building, the improve envelope of the proposed *"sustainable"* shell could reduce thermal gains through the envelope to almost half, resulting in an important size reduction of HVAC equipment (to half of the current case).

Additionally, the upgrade of exterior lamps to LEDs can reduce yearly energy consumption for outdoor lighting by over 40% or even by 100% if the suggested PV panels are installed, meaning a reduction of over 36,300 kg. of CO_2 compared to the current shell (using DECC guidelines for the calculation).

700 REFERENCED STANDARDS

- *2003 EPA Construction General Permit*
- *ASHRAE/IESNA Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential*
- *The Energy Policy Act (EPAct) of 1992*
- *The Energy Policy Act (EPAct) of 1995*
- *International Association of Plumbing and Mechanical Officials Publication IAPMO/ANSI UPC 1-2006, Uniform Plumbing Code 2006, Section 402.0, Water-Conserving Fixtures and Fittings*
- *International Code Council, International Plumbing Code 2006, Section 604, Design of Building Water Distribution System*
- *ANSI/ASHRAE Standard 62.1-2007: Ventilation for Acceptable Indoor Air Quality*
- *ASHRAE Standard 55-2004: Thermal Comfort Conditions for Human Occupancy*
- *SMACNA IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition, Chapter 3, November 2007*
- *ANSI/ASHRAE Standard 52.2-1999: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*
- *South Coast Air Quality Management District (SCAQMD) Amendment to South Coast Rule #1168, VOC Limits, effective January 7, 2005*
- *Green Seal Standard GS-36 (commercial adhesives), Effective October 19, 2000*
- *South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings*
- *Green Seal Standard GC-03 (anti-corrosive and anti-rust paints)*
- *Green Seal Standard GS-11 (commercial flat and non-flat paints)*
- *Carpet and Rug Institute Green Label Plus Testing Program*
- *South Coast Air Quality Management District (SCAQMD) Rule #1168, VOC Limits*
- *South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings*
- *DGNB (German Sustainable Building Certificate)*
- *BREEAM (Building Research Establishment Environmental Assessment Method)*
- *DECC (United Kingdom Department of Energy & Climate Change)*

800 APPENDIXES

810 Appendix 1: Owner's Project Requirement Outline

Owner's Project Requirement

Owner and User Requirements

A) **Description of the project:** [Include a paragraph with a brief description of the project here]
B) **Sustainability and design goals:** [Include a paragraph with a general description of the sustainability and design goals of the project here]
C) **Type of project:** [In a sentence describe the type of project being developed e.g. commercial building, office building, parking garage, etc.]

General Project Information:

Project name:	[Include project's name here]
Owner:	[Include owner's name here]
Type and use:	[Include type of building being developed and the use/uses it will have]
No. of units:	[Include number of units of the project here, if applicable]
No. of floors:	[Include number of floors of the project here]
Square footage:	[Include square footage of the project here]

Construction Schedule Target:

Construction budget:	[Include construction budget here]
Schematic design:	[Projected date for the conclusion of the schematic design]
Design development:	[Projected date for the conclusion of the design development]
50% construction drawings:	[Projected date for the conclusion of 50% of construction drawings]
100% construction drawings:	[Projected date for the conclusion of 100% of construction drawings]
General merchant pricing (GMP):	[Projected date for the conclusion of GMP]
Construction commence:	[Projected date for construction commence]
CO date:	[Projected CO date]

Project purpose, vision and statement:

A) **Project performance and sustainability goals:** [Include main project's performance and sustainability goals]
    a. **Probable performance goals:** [Enlist all performance goals that wish to be achieve in the project]
B) **Building occupant and O&M personnel expectations:** [Include expectations for building occupants and operation and maintenance personnel]

820 Appendix 2: Construction Indoor Air Quality Management Plan Outline

This is a sample outline of a typical Air Quality Management Plan. You can use it as a guide to developing your own.

Construction Indoor Air Quality Management Plan

I *(Include General Contractor or Other Responsible Party name here)*, declare to USGBC that an Indoor Air Quality (IAQ) Management Plan has been developed and implemented for the construction and pre-occupancy phases of the building. The following filtration media was used during construction (if air handlers were operated) and installed after construction:

Installed during Construction

Filtration Media Used	Manufacturer	Model Number	*MERV Value

***Minimum MERV 8 required.**

Installed at the end Construction

Filtration Media Used	Manufacturer	Model Number	*MERV Value

***Minimum MERV 13 required.**

I have provided the following supplementary documentary to support the declaration:

EITHER:

A. *(Photographs – photographs taken on different occasions during construction AND identification of the SMACNA approach featured by each photograph, in order to show consistent adherence to the credit requirements.)*

B. *((I certify that the five Design Approaches of the SMACNA IAQ Guidelines for the Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 Chapter 3, were used during building construction AND I have included a brief description of some of the important design approaches employed.)*

Example A:

This plan describes the measures to be taken to provide good indoor air quality (IAQ) during construction and after construction is complete and the occupants have moved into the building. This plan is based on the SMACNA standard IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 Chapter 3, and the requirements of LEED™ Core & Shell 2009 Certification.
The plan addresses construction IAQ procedures in five areas of concern, which in turn will allow the building to achieve one LEED program point:

(1) Ventilation system protection
(2) Contaminant source control
(3) Pathway interruption
(4) Housekeeping
(5) Scheduling

[Include a paragraph for each point with a brief description and at least 18 pictures]

830 Appendix 3: Sample Outline of a Construction Waste Management Plan

This is a sample outline of a typical Waste Management Plan. You can use it as a guide to developing your own.

Construction Waste Management Plan

Company: [Include Company's name here]
Project: [Include project's name here]
Designated Recycling Coordinator: [Include coordinator's name here]

Waste Management Goals:
- [Define and describe goals here]

Communication Plan:
- [Define and describe communication plan here]

Expected Project waste, Disposal, and Handling:

Demolition Phase			
Material	Quantity	Disposal Method	Handling Procedure
.			

Construction Phase			
Material	Quantity	Disposal Method	Handling Procedure
.			

Appendix 4: Technical Specifications

I. CONCRETE WITH RECYCLED CONTENT

CEMEX: CEM2 & CEM3 blended cements

CEMEX CEM2
CEMEX Extra is a factory produced Portland-fly ash cement that complements our range of Portland (CEM I) cements. The enhanced properties of the product provide benefits in a wide range of concrete, mortar, render, screed and grout applications. CEMEX Extra is manufactured by burning a precisely specified mixture of raw materials containing lime, silica, alumina and small quantities of other materials to form a clinker. The clinker, a selected fly ash and calcium sulfate, (to control setting), are interground to produce a very consistent cement with improved characteristics.
Features/benefits/applications: For use in concrete, mortar, render, screed and grout. Improved workability, cohesion and finishing. Ideal for self-compacting concrete. Enhanced sulfate resistance. Low effective alkali content gives a reduced risk of ASR. Reduced permeability and chloride ion diffusion Reduced risk of thermal cracking Enhanced durability gives increased design life and reduced whole life costs. Consistent, convenient and cost effective.
CEM II Information CEMEX is committed to continuous improvement in environmental and sustainability performance, particularly through utilizing recycled content, minimizing landfill waste and improving our energy efficiency. CEM II cements are factory produced Portland composite cements. CEM II cements from CEMEX are of the Portland-fly ash type. This product contains a minimum of 25% fly ash which is a by-product of Coal Fired Power Stations, making not only more sustainable cement but also enhancing its performance characteristics. 

CEMEX CEM3
CEMEX CEM 3 is factory produced blast furnace cement that complements our range of CEM I & CEM 2 cements. The enhanced properties of the product provide benefits, particularly in respect of durability, in a wide range of applications. CEMEX CEM 3 is manufactured by burning a precisely specified mixture of raw materials containing lime, silica, alumina and small quantities of other materials to form a clinker. The clinker, a selected granulated blast furnace slag and calcium sulfate, (to control setting), are combined by either intergrinding or separate grinding and subsequent blending, to produce a very consistent cement with improved characteristics. CEMEX CEM 3 is suitable for use as an alternative to Sulfate-resisting Portland cement in most aggressive ground conditions.
Features/benefits/applications: For use in concrete, mortar, render, screed and grout. Lighter color. Enhanced sulfate resistance. Low effective alkali content gives a reduced risk of ASR Reduced permeability and chloride ion diffusion. Reduced risk of thermal cracking. Enhanced durability gives increased design life and reduced whole life costs. Consistent, convenient and cost-effective.
CEM III Information CEMEX is committed to continuous improvement in environmental and sustainability performance, particularly through utilizing recycled content, minimizing landfill waste and improving our energy efficiency. CEMEX CEM 3 cement is factory produced blast furnace cement. This product contains a minimum of 40% granulated blast furnace slag which is a by-product of iron production, making not only more sustainable cement but also enhancing its performance characteristics. CEM 3 ® SUSTAINABLE CEMENT

HOLCIM: Envirocore

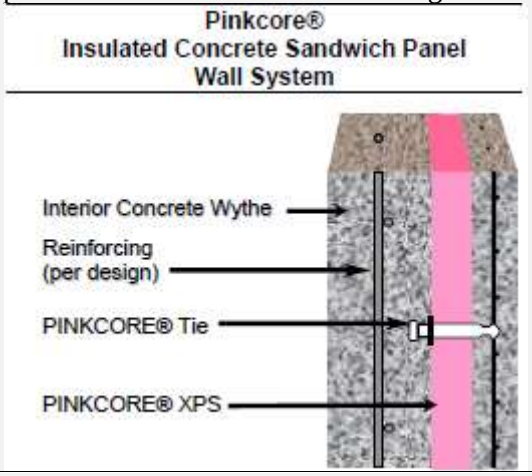
Holcim US developed the Envirocore™ family of products as an integral part of its eco-efficiency program. Envirocore™ products contain material that has been recycled or co-processed. The range includes composite cements, supplementary cementitious materials (slag cement or fly ash) and masonry cements. These are marketed via a dedicated website, which also provides guidance on sustainable construction and sustainable building standards, including LEED (Leadership in Energy and Environmental Design) – a benchmark for the design, construction and operation of high-performance green buildings.

Other environmental performance data for cement, aggregates and ready-mix concrete

EN3, EN10, EN11, EN13, EN28	2005	2006	2007	2005	2006	2007	2005	2006	2007
		Cement			Aggregates			Ready-mix	
Number of sites	127	150	148	337	345	315	864	892	953
Energy and CO_2									
Fuel consumption* (specific) MJ/t	3,176	3,057	3,039	17	21	22	54MJ/m³	15MJ/m³	21MJ/m³
Total MGJ/a	443	452	474	2.7	3.5	3.5	2.0	0.6	0.9
Power consumption* (specific) kWh/t	105	105	105	2.5	2.4	2.5	3kWh/m³	3kWh/m³	3kWh/m³
Total million kWh/a	14,600	15,500	16,250	415	388	381	95	117	124
Indirect CO_2 from purchased power (million tonnes)	5.7	6.1	6.6	n/a	n/a	n/a	n/a	n/a	n/a
Water									
Water consumption l/t*	430	330	340	450	621	647	250l/m³	280l/m³	240l/m³
Total million m³/a	50	53	56	74	102	104	9	11	10
Water recycling systems	n/a	n/a	n/a	50%	47%	50%	77%	72%	72%
Quarry management and rehabilitation									
% of plants operating in sensitive areas	not reported	27%	30%	33%	14%	17%	13%	4%	8%
Approved mining plans by local authorities	93%	97%	94%	90%	83%	87%	n/a	n/a	n/a
Rehabilitation plans in place	71%	89%	90%	86%	81%	81%	n/a	n/a	n/a
Transport									
Road	76%	76%	73%	91%	97%	95%	100%	100%	100%
Rail	16%	19%	18%	n/a	n/a	1%	n/a	n/a	n/a
Water	8%	5%	9%	n/a	n/a	2%	n/a	n/a	n/a
Other	n/a	n/a	n/a	9%	3%	2%	n/a	n/a	n/a
Waste management and recycling									
General waste management system	98%	98%	98%	85%	82%	86%	67%	75%	77%
Returned concrete recycling system	n/a	n/a	n/a	n/a	n/a	n/a	26%	20%	22%
Environmental compliance									
Number of plants/quarries reporting non-compliance cases	18	13	8	9	7	4	18	27	13
Non-compliance cases	24	16	8	9	8	4	21	44	18
Associated fines and penalties (CHF)	165,000	170,000	1,025,000[4]	83,500	39,000	19,500	90,500	176,000	111,500

II. THERMAL INSULATING MATERIALS

OWENS CORNING: Pinkcore™

PINKCORE™ System
PINKCORE® extruded polystyrene (XPS) rigid insulation and ties are designed for use in tilt-up, site cast and precast panels.1 The insulating sandwich panel system provides a fast, efficient method of constructing insulated walls different than surface applied insulating cladding that may compromise the low maintenance and high durability of concrete walls.

Material Properties: PINKCORE extruded polystyrene insulation is manufactured to possess physical properties that comply with ASTM C578, Type IV, including an R value of 5 per inch of thickness2, and 25 psi minimum compressive strength. The closed cell structure of extruded polystyrene makes it highly resistant to water absorption.3 Tightly butted, the straight edge PINKCORE panels create a water resistant and thermally efficient continuous insulation envelope around the building. PINKCORE ties are molded from a high-performance, engineered thermoplastic resin and feature high strength and low thermal conductivity. The ties are designed to hold a face Wythe of concrete affixed to the panel without the need for thermally inefficient metal connectors or solid concrete sections.
Installation: PINKCORE insulation and ties are specifically designed for fast, accurate installation. The PINKCORE insulation is clearly marked with a 16-inch on center dot pattern to ensure accurate placement of the PINKCORE connector ties into the insulation. After casting the exterior concrete Wythe, the PINKCORE insulation and ties are placed in the fresh concrete. The design of the connector tip also ensures easy penetration through the foam, as well as a mechanical interlock into the concrete once it cures. Once the PINKCORE insulation and ties are in place, construction of the inner concrete Wythe continues. Reinforcement, imbeds and lifting inserts are all set in place on top of the PINKCORE insulation and then the concrete is poured. With a compressive strength of 25 psi (3,600 psf), the PINKCORE insulation provides damage resistance from foot traffic and other abuse.

Performance During Lifting:
Because the lifting inserts are located on the inner Wythe, the PINKCORE connector ties are designed to support the fascia Wythe during the lift. A typical three-inch concrete fascia Wythe weighs 37.5 lbs/ft2. Suction force between the casting bed and the fascia Wythe is approximately 25 lbs/ft2. With the connector ties spaced 16-inches on center, each connector tie is required to support 111 lbs.

Typical Physical Properties:
PINKCORE Tight Tolerance boards are available in minimum compressive strengths of 15, 25, 40, and 60 psi. The boards are available in thicknesses from 1" to 4", widths of 24" or 48", and lengths up to 20'.

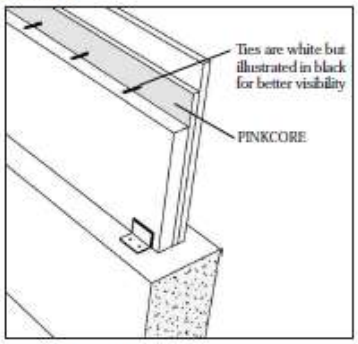
Property	ASTM Test Method	*PINKCORE* Tight Tolerance 15	*PINKCORE* Tight Tolerance 25	*PINKCORE* Tight Tolerance 40	*PINKCORE* Tight Tolerance 60
Compressive Strength @ 10% deformation, psi, min.[2]	D 1621	15	25	40	60
Tensile Strength, psi, min.	D 1623	50	50	50	55
Shear Strength, psi, min.	C 273	15	15	20	35
Shear Modulus, psi, min.	C 273	370	400	500	740
Flexural Strength, psi, min.[2]	C 203	40	50	60	75
Flexural Modulus, psi, min.	C 203	1400	1750	2100	3000
k-factor @ 180 days, 75°F mean, BTU -in/hr-ft²-°F	C 518	0.2	0.2	0.2	0.2
Water Absorption, % vol., max.	C 272	0.3	0.3	0.3	0.3
Water Vapor Permeance, Perm, max.	E 96	1.1	1.1	1.1	1.1
Flame Spread[4,5]	E 84	5	5	5	5
Smoke Developed[4,5,6]	E 84	45-175	45-175	45-175	45-175
Thickness Tolerance, in.	—	± 0.020	± 0.020	± 0.020	± 0.020
Coefficient of Linear Thermal Expansion, in./in./°F	—	2.7 X 10^{-5}	2.7 X 10^{-5}	2.7 X 10^{-5}	2.7 X 10^{-5}
Maximum Service Temperature, °F	—	165	165	165	165

[1] Published values in this table are typical values and should not be considered as specifications. Properties shown are representative values for 2" thick product unless noted otherwise.
[2] Value at yield or 10%, whichever occurs first.
[4] Tested as a 1" thick sample. Value at yield or 5%, whichever occurs first.
[5] These laboratory tests are not intended to describe the hazard presented by this material under actual fire conditions.
[6] Data from Underwriters Laboratories, Inc. Classified. See Classification Certificate U-197.
[7] ASTM E 84 is thickness dependent; therefore a range of values is given.

Limitations:
PINKCORE Tight Tolerance board should not be used in contact with chimneys, heater vents, steam pipes or other surfaces where temperatures exceed 150°F. It is not recommended for applications where sustained temperatures exceed 165 °F.

PINKCORE Tight Tolerance board is susceptible to deterioration or damage from excessive exposure to ultra violet light. Material should be stored in such a manner so as to protect it from exposure to direct sunlight. Polystyrene based foam insulations may be potentially incompatible with some of the solvents used in commercially available adhesives and sealants. Contact an Owens Corning representative for a list of known solvents that are incompatible with extruded polystyrene insulation.

Figure 1



Available Sizes

☐	1.5 in	37.5 mm	Insulation & Ties
☐	2.0 in	50.0 mm	Insulation & Ties
☐	2.5 in	62.5 mm	Insulation & Ties
☐	3.0 in	75.0 mm	Insulation & Ties
☐	3.5 in	87.5 mm	Insulation & Ties
☐	4.0 in	100.0 mm	Insulation & Ties

Description

PINKCORE XPS rigid foam insulation and ties are specifically designed for use in site-cast or precast insulated concrete sandwich wall panels. These products provide a fast, efficient, cost-effective method of improving the thermal performance of commercial buildings. Typical concrete wall panels must be insulated after casting and erection. Using PINKCORE insulation and ties, the panel is insulated during casting, prior to erection. Thus, the insulation is integral to the wall, which results in easier and faster construction. In addition, since the insulation is "sandwiched" between the interior concrete wythe and the fascia wythe, the panel maintains hard, durable concrete surfaces, both inside and out.

PINKCORE Insulation

Manufactured from extruded polystyrene foam (XPS), PINKCORE insulation provides a stable R-value of 5.0 per inch. Since an uninsulated eight-inch layer of concrete has an R-value of less than 1, the addition of 1.5, 2 or 3 inches of PINKCORE insulation (R-values of 7.5, 10 and 15 respectively) dramatically improves the thermal performance of a building. The tight, closed cell structure of PINKCORE insulation also resists moisture penetration, which insures that the thermal performance is maintained over the life of the building. Lightweight properties mean ease of handling.

PINKCORE Ties

Manufactured from a high-performance, engineered thermoplastic resin, PINKCORE ties feature high strength and low thermal conductivity. Unlike other sandwich panel designs which rely on metal or solid concrete connections, the use of PINKCORE ties minimizes the energy-draining effects of thermal bridging and results in a sandwich panel with maximum thermal performance.

Installation

PINKCORE insulation and ties are specifically designed for fast, accurate installation. The PINKCORE insulation is clearly marked with a 16-inch on center dot pattern to ensure accurate placement of the PINKCORE connector ties into the insulation. After casting the exterior concrete wythe, the PINKCORE insulation and ties are placed in the fresh concrete. The design of the connector tip also ensures easy penetration through the foam, as well as a mechanical interlock into the concrete once it cures.

Once the PINKCORE insulation and ties are in place, construction of the inner concrete wythe continues. Reinforcement, imbeds and lifting inserts are all set in place on top of the PINKCORE insulation and then the concrete is poured. With a compressive strength of 25 psi (3,600 psf), the PINKCORE insulation provides damage resistance from foot traffic and other abuse.

Performance During Lifting

Because the lifting inserts are located on the inner wythe, the PINKCORE connector ties are designed to support the fascia wythe during the lift. A typical three-inch concrete fascia wythe weighs 37.5 lbs/ft^2. Suction force between the casting bed and the fascia wythe is approximately 25 lbs/ft^2. With the connector ties spaced 16-inches on center, each connector tie is required to support 111 lbs.

Calculation for Stress on Connector Ties During Lifting

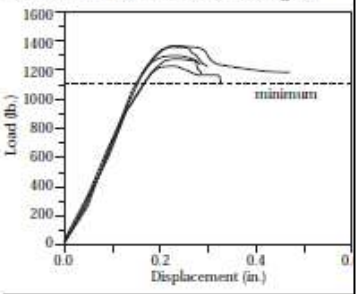
(37.5 lbs. + 25 lbs.) x 1.77 ft^2/tie = 110.63 lbs.

Tensile Strength

A tie was placed in an Instron machine and tested until failure occurred. As shown on the graph below, the nominal tensile strength of each PINKCORE connector tie exceeds the 1,100 lbs. minimum performance, which provides a safety factor of 10 to 1. (Note that standard safety factors on wall panel lifting hardware are typically 5 to 1 or less).

Graph 1

Connector Tie: Tensile Strength



Tie Pullout in Concrete

The tie used in sandwich panel wall construction is subjected to tensile loads during the stripping and erection phases. The magnitude of loading depends on the thickness of the bottom concrete wythe, tie spacing and the suction forces present between the forming bed and the concrete surface.

There are two failure modes seen in tie pullouts. If concrete strength is not sufficiently developed, the tie may pull out with a concrete cone attached. With nominal concrete strengths, PINKCORE ties are designed to interlock mechanically in concrete and designed to fail at the minimum cross section when the pullout force reaches the ultimate tensile strength of the tie. Thus the pullout strength of the PINKCORE tie is typically equal to the tensile strength of the tie itself.

Test Specimens

To investigate this, a series of pullout tests were conducted by Owens Corning. A total of thirty specimens were tested. For each sample, a PVC mold was used to form the concrete. The concrete molds had a diameter of 6 inches and a thickness of 2 inches (see Fig. 2). Twenty specimens were prepared by inserting ties through a 2-inch insulation board, following the standard PINKCORE tie installation procedure. The remaining ten specimens were prepared with a pre-drilled hole in the insulation for comparison with the standard installation of boards and ties. Concrete cylinders were cast to determine the strength of the concrete at the time of testing. The specimens were tested when the concrete reached approximately 2,300 to 3,000 psi.

Test Results

The specimens were tested at two different intervals. The first batch of five pre-drilled and ten standard installation samples were tested after one day. The concrete strength at the time of testing was 2,300 psi. The remaining samples were tested after two days when the concrete strength reached 3,000 psi.

Figure 2 – *Specimens before testing.*

Figure 3 – *A test setup for pullout testing.*

The load was applied to the specimens using an Instron machine with a special jig attached (see Fig. 3). A summary of the concrete strengths and average ultimate pullout strengths at each day of testing are given in Table 1.

In each case, the average ultimate load, regardless of insertion method, was in excess of the nominal tie strength of 1,100 pounds.

Table 1 – Summary of Test Results

Insertion Method	Concrete Age of Testing	Concrete Strength	Number of Specimens	Average Ultimate Load
Pre-drilled	1 day	2300 psi	5	1215 lb
Standard method	1 day	2300 psi	10	1110 lb
Pre-drilled	2 day	3000 psi	5	1220 lb
Standard method	2 day	3000 psi	10	1150 lb

The tensile load on the ties during stripping and lifting depends on the concrete wythe thickness, tie spacing, and suction forces present in the casting bed. These can be quantified as follows for a 3-inch fascia.

Assumption for Calculation of Stress on Ties During Lifting

Area weight of concrete (lbs/sf/in)	12.5
Thickness of fascia (in)	3
Suction force (lb)	25
Ties per square foot (16 in. spacing)	0.5625

Conclusion

These results confirm that the PINKCORE tie has a high factor of safety during stripping and lifting at the concrete strength commonly specified for concrete sandwich panels. A safety factor of approximately 10 is maintained whether the foam is pre-drilled or not.

Shear Strength

As the wall panels are lifted from a horizontal to a vertical position, the load on the PINKCORE connector tie shifts from a tensile load to a shear or flexural load. Because a bond forms between the PINKCORE insulation and the concrete, the samples for testing shear strength were constructed in two different ways:

1. To measure the shear strength of the PINKCORE ties with the concrete-foam bond intact, 4 ft. x 8 ft. test panels were constructed by first pouring the three inches of concrete, then placing 2" thick PINKCORE insulation on the fresh concrete and inserting 18 connector ties. Another three-inch layer of concrete was then poured on top of the foam in each test panel. Thus, the final assembly was representative of standard wall panel with PINKCORE insulation.

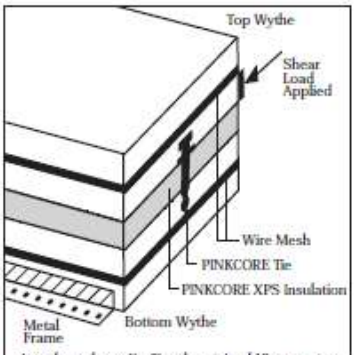
2. In order to determine the strength of the PINKCORE ties alone (without the effects of the concrete-insulation bond), panels were constructed as above, but with two sheets of polyethylene between one concrete-insulation interface.

Application of the shear load on both types of panels was accomplished with a test apparatus that was custom-made for that purpose. A reinforced metal frame held the bottom wythe in place while a hydraulic ram applied pressure to the top wythe. The load was evenly distributed across the four-foot width of the top wythe.

Graph 2 shows the shear strength of the 18 connectors in the 4 ft. x 8 ft. panels, with and without the polyethylene film. A significant concrete-foam bond is formed in the conventional panel, without polyethylene. This bond eventually breaks at a displacement greater than 0.2 inches. While the bond can be seen as beneficial, the strength of the PINKCORE connector tie alone is sufficient to support the concrete fascia during lifting and installation.

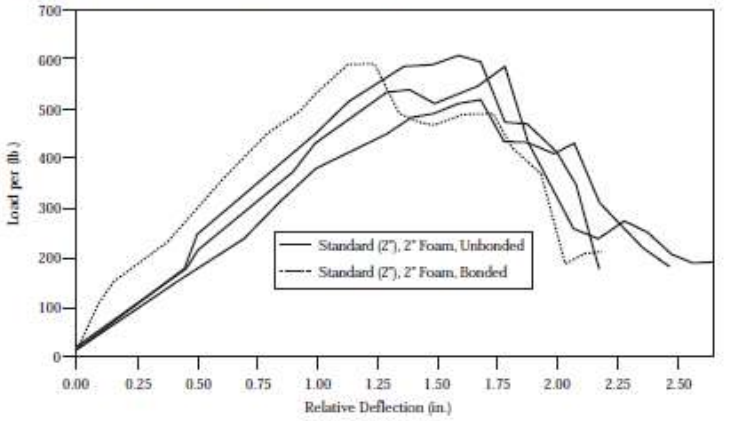
Figure 4

Shear Testing Apparatus Illustration



Actual panel was 4' x 8' and contained 18 connectors.

Graph 2 – *Load-Deflection Curve for 4' x 8' Sandwich Panel in Shear*



The weight of a 3-inch thick, 4 ft. x 8 ft. wythe is 1,200 lbs. During testing, the test panel exhibited a minimum shear strength of approximately 9,000 lbs. and a maximum of 11,000 pounds, with the variance depending on the presence or absence of the concrete-foam bond. Thus, the PINKCORE connector ties will easily support the weight of the concrete, whether or not the concrete-foam bond is considered.

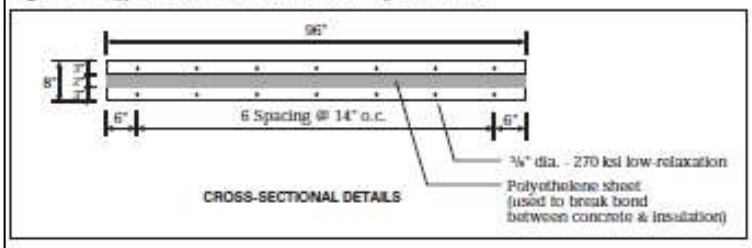
Full Scale Testing for Composite Action

The primary function of ties in sandwich wall panel construction is to hold the two concrete wythes together. Composite action occurs when the ties are capable of transferring shear forces from one concrete wythe to the other. The degree of composite action varies depending on the stiffness of the ties and their capacity to transfer forces. This important property needs to be considered in the design calculations. The Precast/Prestressed Concrete Institute's (PCI) Precast Sandwich Wall Panels Committee recommends designing a panel in three different ways, i.e. fully composite, noncomposite and semi-composite[1] depending on the manufacturer's testing of the system.

A higher degree of composite action provides a good shear transfer between the concrete wythes allowing a thinner panel. But it may also result in excessive bowing of the panel due to thermal deformations of the exterior wythe when subjected to varying temperature swings. Thus, for taller panels, noncomposite action is desirable where the growth of the outside wythe is independent and does not affect the panel deflections. Noncomposite ties are primarily used to resist tensile loads during the stripping, transportation and erection stages. Hence, to control deflections in a panel caused by thermal swings, a noncomposite panel would be ideal though it may not be structurally efficient.

To evaluate the load-deflection capacity of the panels with the PINKCORE system, full-scale testing on three panels was conducted by an independent testing laboratory. The panels were 8' wide by 30' 8" long with a 3"- 2"- 3" cross-section. Detailed descriptions of the panels and the test methodology follows. A comparison of the test results to theoretical calculations is given at the end.

Figure 5 – *Typical Cross-Sectional Details of Test Panel*



Panel Casting

Three panels were cast by the precaster following the same procedure as their production panels. Figure 5 illustrates the typical cross-sectional details of the test panel. Descriptions common to all panels and the material strengths used are given below.

Width	8'
Length	30' 8"
Thickness	8" (3"- 2"- 3")
Concrete density	Normal weight (145 pcf)
Concrete strength	
At prestress transfer	5,400 psi
At 28 days	5,720 psi
Reinforcement per wythe	
Prestressing strands	7 – 3/8" diameter 270 ksi low-lax
Welded wire fabric	6 x 6-W2.9 x W2.9
Initial prestressing force:	17.2 kip
Insulating system:	PINKCORE XPS & Ties
Lifting anchors:	Burke – 8 per panel with two U-loops for top lifting

Two out of three of the panels were made with two slip-sheets (polyethelene) to break the concrete-to-insulation bond. The standard tie spacing of 16" on center was used for all panels. Table 2 summarizes the details of each panel tested. Figure 6 shows panel reinforcements on the precast bed before the concrete was poured.

Table 2 – *Details of Test Panels*

Panel Number	Bond Present	Tie Spacing
1	Yes	16"
2	No	16"
3	No	16"

Figure 6 – *Test Panels During Casting*

The panels were stripped flat from the casting bed using 8 lift points after 6 days of curing and were moved outside for storage before shipping them to the test site. Panels were shipped with supports at lift points in flat-bed trailers stacking two on each trailer. The panels had been cured for 6 to 7 weeks when they were tested.

Test Chamber and Setup

A new steel vacuum test chamber specifically designed for testing these panels was built. The chamber was 5' deep to accommodate large deflections and to allow for visual inspection by personnel after the test was completed. The top and bottom of the panel were supported on steel channel beams which were allowed to rotate during the test. The panels were first flat-lifted with 8 lift points using a crane. Once air-lifted, they were rotated to a vertical position using the two top U-hooks for positioning into the test chamber. The gap between the panel edges and chamber walls was sealed to make it airtight for testing. Two linear variable displacement transducers (LVDT) were attached at mid-height and quarter points to record the deflections. Strain gauges were also installed at various locations in the panel to measure the strain on the concrete surface. All instrumentation was connected to a data acquisition system using a computer for recording the data. Figure 7 shows a specimen in the test chamber before the load application.

Figure 7 – *Full Scale Panel Subjected to Wind Loading During Test*

Panel Testing

A uniformly distributed load (udl) was applied using suction force in the chamber to simulate wind loads. The load was increased incrementally until a large midspan deflection occurred and released to let the panel recover back to its original position. Thus the load-unload was repeated for at least 4 cycles to record the load-deflection data. The panel could not be loaded to failure for safety reasons.

Several observations were made in addition to gathering test data:

- The panels experienced one to two cracks on interior concrete wythe near the mid-span and cracks closed when unloaded.
- A small residual deflection was observed at mid-height after the test was completed.
- The insulation-to-concrete bond was broken at the top and bottom of the panel to one third of the height.
- No concrete spalling was observed during the test.
- The panel was intact in one piece even after being removed from the chamber and laid horizontally on the ground.

The same test procedure was repeated for all panels and the recorded data was analyzed to evaluate the degree of composite action provided by the PINKCORE ties. The LECWall program[3]

[3] LECWall - Precast Concrete Wall and Column Design Program, Release 10, Losch Engineering Corporation, Palatine, IL, 1999

(by Losch Engineering Corporation) was used to develop the theoretical load-deflection curves for comparison.

Test Results and Evaluation

The recorded data was used to plot load-deflection curves to compare with the theoretical results. The load-deflection curves for the three panels with 16" tie spacing are shown in Graph 3. Note that the curves are based on the raw data from testing and curtailed to fit the chart scale.

Using the LECWall program, a series of load-deflection curves were developed for various degrees of composite action (in increments of 10%) in addition to noncomposite and fully composite behavior. Actual material properties from the test specimens were used in the program. The program was run with suction loads increasing from zero to failure. Graph 4 shows a comparison of load-deflection behavior between actual data and the theoretical predictions using the program. The unbonded curve is an average of two panels tested with a similar configuration.

In Service

The tie is exposed to wind loads, and a highly alkaline environment while in service.

Wind Loads

Wind loads are derived from tables published by Factory Mutual.* For example, here is a typical wind load determination for central Ohio:

Wind Force:	Central Ohio
100 year max	90 mph
Ground roughness	Type C
Building height	30 feet

From table: Wind pressure 27 lb/ft^2.

Data Sheet 1-7, "Wind forces on Buildings and other Structures," Factory Mutual Loss Prevention.

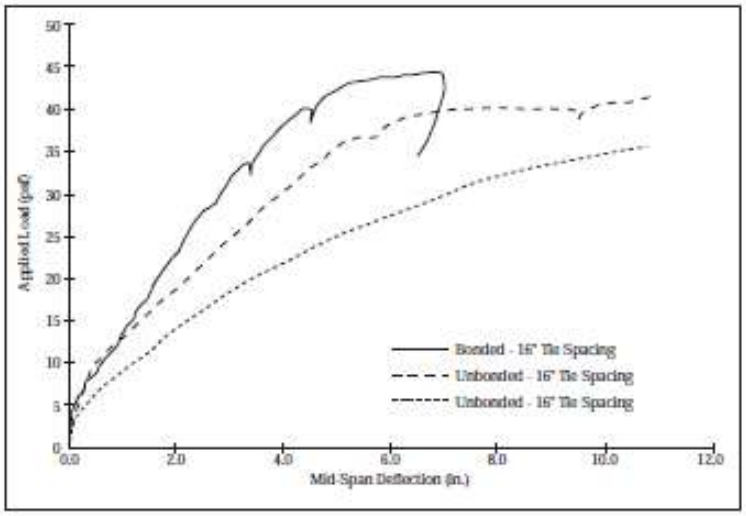
The maximum stress on the building comes at the corners. To calculate the corner stress, multiply the panel wind pressure by a factor of two; in this case, the result is 54 pounds per square foot.

Maximum Wind Load Calculation

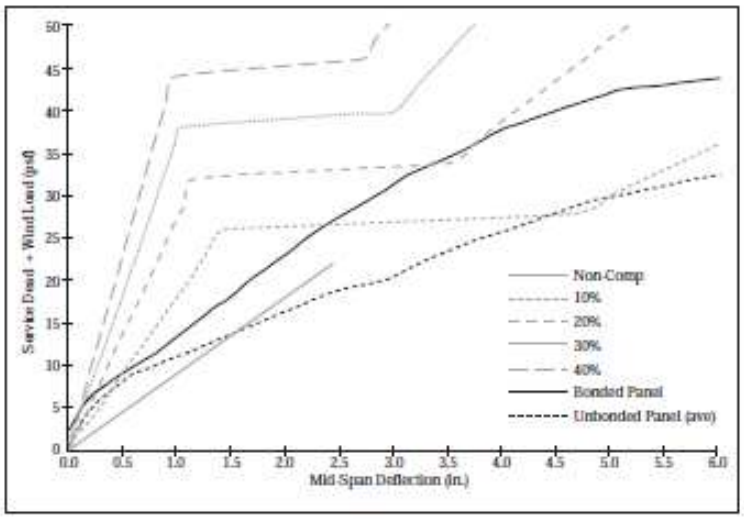
The calculation for maximum load on the connector tie becomes:

54 lbs/ft^2 x 1.77 ft^2/tie = 96 pounds per tie

Graph 3 – *Load-Deflection Curves from Testing*



Graph 4 – *Comparison of Load-Deflection Behavior Between Actual Data and Theoretical Predictions*



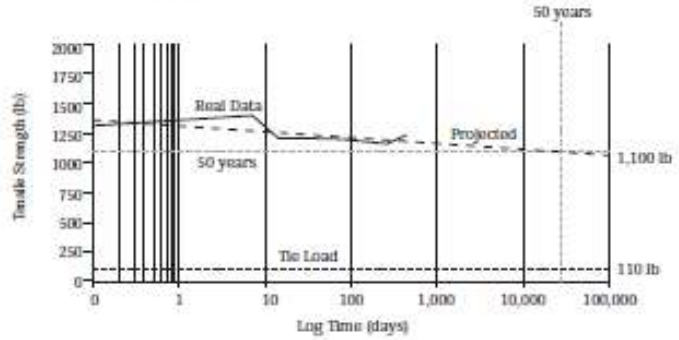
As these calculations show, PINKCORE ties allow for a safety factor in excess of 10:1 in most parts of the United States.

Alkaline Environment

The tie must retain its strength even after being exposed to an alkaline environment while under stress. To simulate this condition, the PINKCORE connector tie was put in a jig which placed the tie under stress. The tie and jig combinations were then put into a bath of cement extract at an elevated temperature to accelerate the test.

At regular intervals of time, the ties were removed and tested for tensile strength. After 365 days of this accelerated testing, the tensile strength of the connector ties continued to be in excess of the nominal value of 1,100 pounds (Graph 5). In fact, extrapolation of this severe test confirms the exceptional alkaline resistance of this resin, as substantial safety factors are maintained for many years.

Graph 5 – *PINKCORE Tie: Alkaline Resistance*



Fire Performance of Concrete Sandwich Panels

The fire resistance of concrete is well understood. Major building codes allow for a calculated method of fire resistance when concrete construction is specified. This includes the fire resistance of multi-layered panels that have concrete in at least one layer. These calculated resistances may be used to satisfy building code requirements for all hourly fire ratings.

In addition, Owens Corning has performed its own testing at the Owens Corning Science & Technology Center in Granville, Ohio.

Building Codes

All four national model building codes (UBC, SBC, NBC, and IBC) use the methodology for calculating fire resistances for concrete sandwich panels outlined in the Precast/Prestressed Concrete Institute's *Design Handbook*[3] and discussed in detail in the PCI's *Design for Fire Resistance of Precast Prestressed Concrete*[4].

This methodology allows for fire resistances to be established for each layer in the panel and for these resistances to be summed in such a way that results in the fire resistance of the whole panel. Use of these calculations is explicitly allowed as an alternative to fire tests of a specific wall assembly.

[3] *PCI Design Handbook*, 4th Edition, Sections 9.3.6., 4-6, pg 9-33 – 9-34, Precast/Prestressed Concrete Institute, Chicago, IL.
[4] *Design for Fire Resistance of Precast Prestressed Concrete*, 2nd Edition, MNL124-89, Precast/Prestressed Concrete Institute, Chicago, IL.

The Rational Design Method

The Rational Design Method for fire resistance is based on research conducted at the Portland Cement Association (PCA). Essentially, the method has two steps. First, the fire resistance of each layer of material is established from tabulated test data. Second, the individual resistances are summed using the following calculation.

Calculation of Fire Resistance for Multilayer Concrete Panels

$$R = (R_1^{1.59} + R_2^{1.59} + \ldots + R_n^{0.59})^{1.7}$$

R is the fire resistance for the panel in minutes. R_1, R_2..., R_n indicate the fire resistance for the individual components of the panel in minutes.

The fire resistances for the individual layers of concrete may be calculated using the equation cited above, and the data from model code tables such as IBC table 720.2.1.2. Table 3 shows fire resistance calculated using the IBC table for siliceous aggregate concrete curve.

Table 3 – *Approximate Fire Resistance of Concrete Layers*

Thickness of Individual Concrete Layer or Wythe	Fire Resistance in Minutes
2"	24
3"	46
4"	78
5"	120
6"	173
7"	230

Data from the Precast/Prestressed Concrete Institute,[3,4] footnoted below, indicates that for polystyrene foam insulation, a fire resistance of 5 minutes is most appropriate for foam thicknesses greater than one inch. Note that, as a result, changing the thickness of the foam has no impact on fire performance.

Fire Test Results

The hourly fire resistance rating for concrete walls is determined by the test standard ASTM E 119. In this test, one side of the full-size wall sample is exposed to the interior of the test furnace, while the other side is exposed only to ambient room conditions to an ultimate temperature of 2000 °F in 4 hours.

There are several criteria in the ASTM E 119 standard which determine the actual fire resistance rating for a given wall. However, the criteria which most often determines the rating for concrete walls is the temperature rise of the unexposed wall surface. This criteria states that the surface temperature of the unexposed side cannot increase 250 °F above the ambient room temperature. Thus, if the ambient room temperature is 70 °F, the maximum allowable surface temperature is 320 °F. The time to reach this maximum temperature determines the hourly rating for the wall assembly.

As a way of confirming the PCI results and the performance of the PINKCORE System, Owens Corning selected a 2.5" exterior layer of concrete and a 5.5" interior layer of concrete with 2" of PINKCORE XPS insulation in between. According to the Rational Design Method described previously, this combination should produce a fire resistance, as defined by the E 119 criteria, greater than four hours.

The E 119 procedures were followed as closely as possible given the capabilities of the Owens Corning facility; the application of the flame, the temperature curve and instrumentation were all in accordance with E 119 protocol, except the size of the sample.

In fact, at the end of four hours, the temperature at the face opposite the furnace had risen only 13 °F above ambient, far below the 250 °F maximum.

Fire Resistance of Typical Panels

Table 5 shows the results of performing the calculations described using the information from Table 3. Please note that changing the thickness of the insulation does not change the fire resistance calculation result.

When designing an insulated panel with a particular fire rating, the roof and the walls must both achieve that rating since the roof typically provides the rigidity of the building.

Table 5

Calculated Fire Resistance for Typical Panel Cross Sections (in hours)

Thickness of Outside layer	Thickness of inside layer of concrete					
	2	3	4	5	6	7
2	1.8	2.3	3.2	4.2	5.3	6.6
3	2.3	2.8	3.7	4.9	6.1	7.4
4	3.2	3.7	4.8	6.1	7.4	8.9

Based on fire resistances from Table 1

Conclusion

Concrete sandwich panels with PINKCORE insulation and ties may be designed with any level of fire performance desired. The Rational Design Method gives the designer a way to design in-fire performance.

Thermal Performance

PINKCORE extruded polystyrene rigid foam insulation meets ASTM Standard Specification C-578, Type IV and has the thermal resistance of 5.0 °F h ft²/Btu per inch (R per inch).

Table 4 – *PINKCORE Insulation Thermal Performance*

Thicknesses IN	Thicknesses MM	R-value
1.5	37.5	7.5
2.0	50.0	10.0
2.5	62.5	12.5
3.0	75.0	15.0
3.5	87.5	17.5
4.0	100.0	20.0

Availability

PINKCORE insulation and ties have been available for delivery since September, 1997. Shipments are made from the Owens Corning plant in Tallmadge, Ohio, or from Owens Corning's authorized distributors of FOAMULAR® insulation products.

Application Recommendations

While the energy standard ASHRAE 90.1 is a United States standard, and has been adopted into building codes in many areas of the USA, it is completely appropriate for buildings anywhere in the world. A building constructed using ASHRAE 90.1 principles – whether the code applies or not – will deliver the thermal performance the owner expects.

The requirements of Standard 90.1 call for increased energy efficiency in four primary areas:

- Lighting
- Building Envelope
- HVAC systems and equipment
- Service water heating

The answer to how much insulation a building needs and where should it be placed lies in the calculations that accompany ASHRAE 90.1. Using Owens Corning's proprietary software, designers can measure the "tradeoffs" between insulating the walls and insulating the roof. And when the determination is made, the designer may very well be able to downsize the HVAC requirements thus saving even more on both first costs and life-cycle costs for the building.

PINKCORE extruded polystyrene rigid foam insulation and ties create an opportunity for the architect/engineer to take advantage of the speed and low cost of insulated wall, while meeting owner and code demands for a thermally efficient building envelope.

In 65% of 211 major metropolitan areas studied by Owens Corning, no block wall or uninsulated block/concrete wall design met the ASHRAE 90.1 code requirement for maximum thermal usage with roof insulation rated less than R-45. ASHRAE 90.1 compliance can easily be met in all areas of the country with PINKCORE insulation and connector ties.

Other Information

Complete installation instructions for PINKCORE insulation and connector ties (Pub. No. 15-IN-22061) are available from your Owens Corning representative.

Shipping

PINKCORE insulation is shipped on open trucks, the same way the company's FOAMULAR® extruded polystyrene rigid foam insulation is shipped. The insulation may be shipped to the distributor's yard, a precast plant (in the case of a precast order) or the job site (in the case of a tilt-up order). The following chart shows square feet of insulation per truck based on 4 ft x 8 ft sheets:

Table 6 – *Loadout Data by Thickness for 4 ft x 8 ft Sheets*

Insulation Thickness	Square Feet per Truckload
1.5"	24,576
2.0"	18,432
2.5"	14,745
3.0"	12,288
3.5"	10,532
4.0"	9,216

The PINKCORE ties are packaged in cardboard boxes with 600 ties per box. For every 1,000 square feet of 16-inch on-center-marked insulation, Owens Corning will ship one box of ties. For odd square footage amounts, Owens Corning will ship enough ties to complete the job. If a customer requires additional ties for the job, Owens Corning will charge for the additional boxes of ties.

PINKCORE ties are shipped separately from the insulation via ground carrier. The ties may be shipped to the distributor's yard or to a precast plant, but may not be shipped to a job site where a permanent address has not been established. For tilt-up orders, the ties will be shipped to the distributor and the distributor will arrange for delivery to the job site.

CEMEX: Concreto Ahorrador de Energía (CAE)

LA VERSATILIDAD EN LAS OBRAS

O_2 Footprint

USOS

- Elementos divisorios para salas de cine y lugares de reunión
- Capas de nivelación en pisos o losas
- Para aligerar cargas muertas en la estructura
- Muros y losas de viviendas de concreto tipo monolíticas
- Paneles de concreto prefabricados

VENTAJAS

- Por sus mejores propiedades térmicas representa un ahorro de energía para el usuario final
- Excelentes propiedades acústicas
- Permite reducir las cargas muertas en las estructuras
- Su alta trabajabilidad favorece las operaciones de colocación y elimina la aplicación de vibradores
- Es apto para ser bombeable
- Ofrece una mayor resistencia a la tensión diagonal en muros
- Es ambientalmente amigable debido a que promueve el ahorro de energía
- No es tóxico
- Este concreto cuenta con características sustentables*

*HUELLA ECOLÓGICA PE´s CEMEX

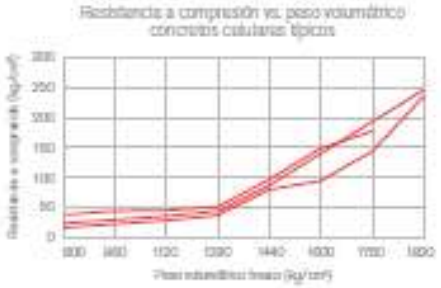
DATOS TÉCNICOS

Concreto Fresco:

- Su conductividad térmica va de 0.40 a 0.80 W/m² °C
- Revenimiento de 10 a 27 cm

Concreto Endurecido:

- Resistencia a la compresión a los 28 días de hasta 200 kg/cm²
- Peso Volumétrico de 1,200 a 1,900 km/m³



* Conductividad térmica ASTM C-518
* Coeficiente de expansión térmica ASTM C-228

CEMEX CONCRETOS

III. SKYLIGHTS

STABILIT: Makrolon™

MAKROLON™

Celular (Multi)

Transmisión de luz, resistencia y estética

MAKROLON Multi, es un laminado plástico extruido a base de resina de policarbonato, con alta tecnología de Bayer; que además cuenta con una capa de protección contra los efectos de intemperización, producidos por los rayos UV. Makrolon es el material recomendado para lograr la fusión de estética y funcionalidad gracias a la excelente transmisión de luz, flexibilidad, ligereza, transparencia y resistencia al impacto.

IQ-Relax

¡En el interior se está siempre bien!

Los productos de la nueva generación de láminas Makrolon multi IQ-Relax poseen en su estrutcura un sistema "inteligente" que se adapta automáticamente a las condiciones ambientales ya que en los días de verano dejan pasar solo la luz, impidiendo la entrada de la mayor parte del calor gracias a sus propiedades aislantes garantizando un ambiente confortable y una sensación de relax.

Makrolon® SL

Con protección UV

Cuenta con protección en una de sus caras contra dañinos rayos UV, que además de filtrarlos, protege y cubre todo lo que este abajo de ella. Cuenta con una garantía que se ha documentado por años con pruebas realizadas tanto en laboratorios como en el campo, estos resultados muestran un mejor desempeño que los productos de la competencia, por lo cual cubre resistencia a UV (amarillamiento), perdida de transmisión de luz y rotura.

SISTEMA DE ACRISTALAMIENTO PLANO SELECCIÓN DE HOJA

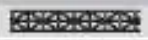
Apoyo en Sentido Ancho de Hoja	Apoyo en Sentido Largo de alveolos (mm) 500	670	1000	1500	2100
MAKROLON 4/2					
Ancho 2100 mm	5	4	6	2	1
Ancho 1750 mm	6	5	7	3	2
Ancho 1500 mm	7	6	8	4,5	3.5
Ancho 1250 mm	8	7	9	4	3
Ancho 1000 mm	10	9	10	5	4
Ancho 750 mm	22	19	18	7	6
Ancho 500 mm	50	40	38	20	18
Ancho 250 mm	135	130	125	100	75
MAKROLON 6/2					
Ancho 2100 mm	7	6	7	4	3
Ancho 1750 mm	8	7	8	5	4
Ancho 1500 mm	9	8	9	6	5
Ancho 1250 mm	12.5	11	10	7	6
Ancho 1000 mm	24	20	19	8	7
Ancho 750 mm	48	30	28	14	9
Ancho 500 mm	110	85	72	30	25
Ancho 250 mm	250	200	200	135	130

CARGA EN Kg/m²

Apoyo en Sentido Ancho de Hoja	Apoyo en Sentido Largo de alveolos (mm) 500	670	1000	1500	2100
MAKROLON 8/2					
Ancho 2100 mm	8	6.5	9	4	3
Ancho 1750 mm	10.5	8	10.5	4.5	3.5
Ancho 1500 mm	14	12.5	12.5	6	4.5
Ancho 1250 mm	23	20	20	8	6
Ancho 1000 mm	35	28	26	14	12
Ancho 750 mm	73	52	49	25	20
Ancho 500 mm	150	125	123	65	50
Ancho 250 mm	275	250	250	200	175
MAKROLON 10/2					
Ancho 2100 mm	12.5	12	12	6	6
Ancho 1750 mm	16	16	16	7	7
Ancho 1500 mm	23	20	20	10	9
Ancho 1250 mm	30	25	24	16	14
Ancho 1000 mm	50	45	40	23	18
Ancho 750 mm	85	75	70	45	25
Ancho 500 mm	175	150	150	100	75
Ancho 250 mm	350	325	325	300	275

CARGA EN Kg/m²

ESPECIFICACIONES TÉCNICAS LAMINADOS MAKROLON CELULAR MULTI

ESPESORES	2 / 4 mm	2 / 6 mm	2 / 8 mm	2 / 10 mm	3 / 16 mm XP
Estructura					
Peso Kg/m²	0.8	1.3	1.5	1.7	2.5
Radio de curvatura en mm	750	1000	1250	1500	3000
Flamabilidad (E84/01)	A1	A1	A1	A1	A1
Transmisión de luz (%):					
Cristal	82	79	79	79	58
Bronce	48	45	46	42	46
Blanco	26	18	14	11	40
Azul	45	43	42	38	ND
Verde	49	49	49	49	ND
Gris	48	45	46	42	ND
Gris Metálico	15	12	12	12	ND
Opalino	51	45	46	48	ND
Anchos disponibles Std.	1.22, 1.83 y 2.10 mts				
Largos Std.	2.44, 3.66, 4.88, 6.10, 7.32, 8.54 y 12.20 mts				

ESPECIFICACIONES TÉCNICAS LAMINADOS MAKROLON SÓLIDO

	MAKROLON GP Sin Protección UV	**MAKROLON SL** Con Protección UV	**MAKROLON AR** Resistente a la Abrasión
Espesores	1.5, 3, 4.5, 6 y 9.5 mm	3, 4.5, 6 y 9.5 mm	desde 3 mm hasta 12.7 mm
Colores	Cristal	Cristal en todos los espesores Bronce: 3, 4.5 y 6 mm	Cristal y Bronce
Medidas	1.22 y 1.83 x 2.44 mts	1.22 y 1.83 x 2.44 mts	1.22, 1.52 y 1.83 x 2.44 mts

Otros largos y bobinas sobre pedido

Para mayor información sobre datos técnicos de nuestros productos consultar con su representante de ventas.

POLYGAL: Thermogal™

THERMOGAL™

Combines highly effective thermal insulation with extra strength for low-pitch roofing.

- Suitable for cold climates - extremely low U-Value
- Save on heating energy costs
- Bright, transparent look, large range of colors, shades and reflective coatings.
- Covered by 10 Year Warranty for color, light transmission and strength
- Can be cold-bent to recommended radii
- Best insulation performance during cold winter nights
- Rigid sheet structure provides extra strength under wind and snow loads. To see sheet performance under loads, go to "Support / Wind Load Charts".
- Recommended Uses: Low pitch coverings, Lean-to conservatories, Large span structures, Stadiums, Closed structures with interior climate control, Industrial windows

Technical Specifications:				
Sheet thickness (mm)		25	32	35
Structure				
Weight kg/m 2 (lb/ft 2)		3.5 (0.30)	3.3 (0.25)	4.0 (0.24)
Minimum cold bending radius mm (inch)		4.37 (14.9")	3.3 (0.25)	6.1 (20")
U-Factor by ASTM C 177 W/m² • ºC		1.7 (0.31)	1.4 (0.25)	1.36 (0.24)
Light transmission by ASTM D I494 (%)	**Clear**	79	73	67
	Ice	54	51	47
	Primalite	18*	15*	-
	Silhouette Gold	-	43	-
	Silhouette Pearl	-	45	-
	Spring	-	52	-

EVERLUX: Solatube™

SOLATUBE™

MAJOR INDUSTRIES: Guardian 275™

SOLATUBE™

1 **Cost-effective:** Utilizing natural light cuts down on energy use and related costs - excellent for warehouses, barns, hangars, etc. Insulation can also be added to Guardian 275® panels for enhanced thermal performance.

2 **Economical:** Competitve pricing - combined with industry-leading warranties - ensures that you're making the right investment for your project... and budget.

3 **Tough:** Third-party testing and in-the-field performance proves that our skylight and curtainwall systems are built to last - in any climate.

4 **Not "Stripped Down":** No-charge integral water management, high-performance sealants and innovative glazing (such as our Ultimate Series™ FRP) go beyond industry standards.

5 **Versatile:** We offer everything from custom skylights and curtainwall to Quick Ship Skylights™ and economical Auburn® acrylic domes and pyramids that can be delivered to your site within days.

6 **Effortless:** Need daylighting fast? Visit us at www.majorskylights.com and use our SkyPrice™ system. After you fill out the online form, you will be contacted within one business day with a quote. It's that simple! For immediate service, call us toll-free at 888-759-2678.


Detroit River Outfall, Detroit, MI.


Detroit River Outfall, Detroit, MI.


Green Bay Transit Facility, Green Bay, WI.


Green Bay Transit Facility, Green Bay, WI.

GLAZING OPTIONS:
- Translucent FRP
- Glass
- Polycarbonate Multiwall
- Acrylic

THE ULTIMATE IN VERSATILITY

Major Industries, Inc. offers a wide variety of custom color and finish options, including a unique and colorful solution for hiding exterior fasteners on selected skylights and translucent curtainwall applications. Imagine for one moment a recessed connector system with color-coordinated trim so flat that it blends into the finish color of the retainer caps—that's what Trim Tones™ offers. Add a splash of color and the same flat trim strip makes a bold statement as an accent stripe. Trim Tones™ are a great way to display eye-catching color combinations in a unique way.


Blue Harbor Resort, Sheboygan, WI.

WHY YOU SHOULD CHOOSE MAJOR INDUSTRIES

We work closely with architects and specifiers every day to develop high-value designs—it's a responsibility we take seriously. We strive to produce top quality, cost-effective, leak-free daylighting that owners demand and deserve. From simple translucent curtainwall to complex polygon skylights, you can rely on the people at Major to help you arrive at a reliable and cost-effective daylighting solution for your next project.

Your decision to use Major Industries on your next daylighting project is a sign of trust, and we work hard to exceed our customer's expectations. Our stringent quality standards and advanced technology allow us to have one of the lowest warranty costs in the skylight business today—and don't forget to ask about our huge percentage of repeat customers and excellent on-time delivery record!

Give us the opportunity to supply you with the best daylighting solutions and *your satisfaction is guaranteed.*

GUARDIAN 275® PERFORMANCE	**FACE SHEET COLOR COMBINATIONS** Exterior Sheet Color / Interior Sheet Color			
	Crystal / Crystal	Crystal / White	White / Crystal	White / White
Light Transmission				
No Insulation (%)	64	40	31	24
Insul 24 (%)	33	25	21	18
Insul 15 (%)	23	19	17	15
IMG 125 (%)	7	5	5	4
Solar Heat Gain Coefficient				
No Insulation	0.52	0.38	0.31	0.24
Insul 24	0.24	0.21	0.18	0.15
Insul 15	0.22	0.19	0.17	0.14
IMG 125	0.09	0.09	0.07	0.06
Center of Panel U-factor				
No Insulation	0.48			
Insul 24	0.20			
Insul 15	0.17			
IMG 125	0.08			
Certified System U-Factor	**Wall System**		**Sloped System**	
	Non-Thermally Broken	Thermally Broken	Non-Thermally Broken	Thermally Broken
No Insulation	0.60	0.58	0.66	0.64
Insul 24	0.32	0.30	0.39	0.36
Insul 15	0.29	0.27	0.36	0.33
IMG 125	0.21	0.20	0.27	0.25
CRF	Vertical Wall - 81 / Sloped Glazed - 75			
UV Transmittance	<0.01			

Additional sheet colors available. Please contact Major Industries, Inc. for related performance data.

GUARDIAN 275® 4-INCH PERFORMANCE	FACE SHEET COLOR COMBINATIONS Exterior Sheet Color / Interior Sheet Color			
	Crystal / Crystal	Crystal / White	White / Crystal	White / White
Light Transmission				
No Insulation (%)	64	40	31	24
Insul 10 (%)	19	17	14	12
IMG 125 (%)	4	3	3	3
Solar Heat Gain Coefficient				
No Insulation	0.52	0.38	0.31	0.24
Insul 10	0.15	0.13	0.12	0.10
IMG 125	0.06	0.06	0.05	0.05
Center of Panel U-factor				
No Insulation	0.48			
Insul 10	0.11			
IMG 125	0.06			
Certified System U-factor	**Thermally Broken Wall System**			
No Insulation	0.55			
Insul 10	0.20			
IMG 125	0.16			
CRF	Vertical Wall - 88			
UV Transmittance	<0.01			

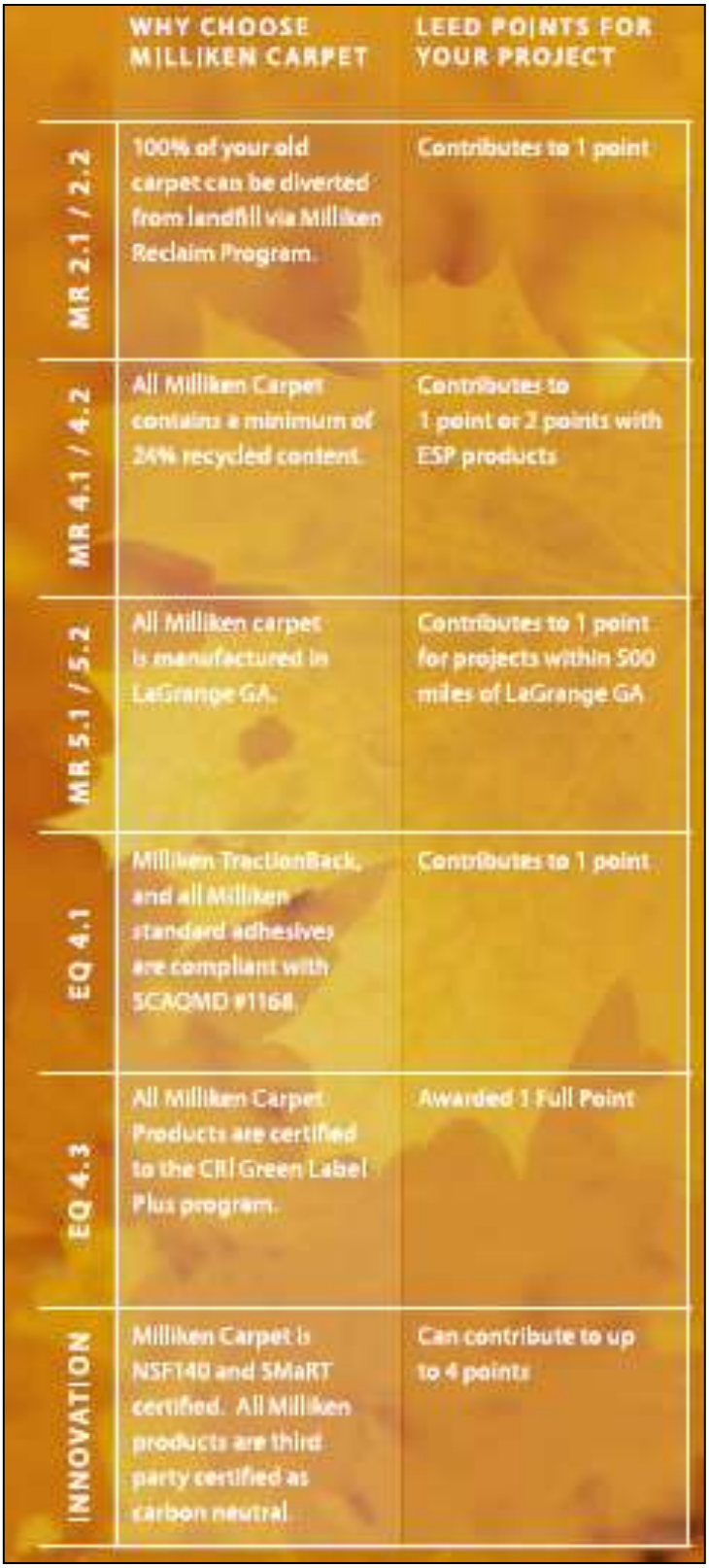
Additional sheet colors available. Please contact Major Industries, Inc. for related performance data.

IV. ENVIRONMENTALLY FRIENDLY FINISHES

- **CARPET PROVIDERS**

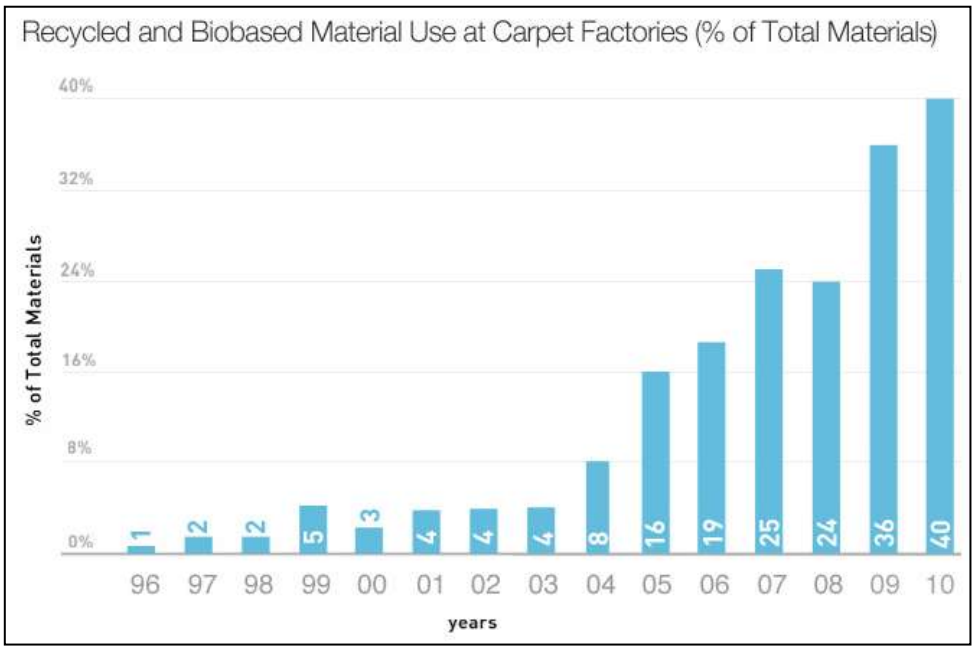
  INTERCORP CONTRACT RESOURCES: Milliken Carpets

Milliken scientists invented a technology to keep carpet tiles in-place without the need for wet glues or "peel and stick" dry adhesives that contain VOCs. The invention was TractionBack® carpet backing, a high-friction coating that's applied to Milliken's modular flooring. Carpet tiles with TractionBack® carpet backing stay put underfoot yet can be easily moved and repositioned. No other modular carpet contributes more to LEED certification than Milliken modular carpet with TractionBack® carpet backing.
Materials & Resources (MR) ***MR Credit 2.1 & 2.2 Construction Waste Management*** Milliken reclamation program ensures that the replaced carpet is managed in an environmental and socially responsible way. It has a nationwide network of recyclers that specialize in recycling one or more carpet types including Milliken Earth Square® process of finding reuse/renewal outlets for carpet tiles. ***MR Credit 4.1 & 4.2 Recycled Content*** Milliken modular carpet contains a minimum of 24% post industrial recycled content. ***MR Credit 5.1 & 5.2 Regional Materials*** All projects within 500 miles of Richmond VA, Columbus OH, Shreveport LA, and Ft. Myers FL, can earn credits towards the regional materials point.
Indoor Environmental Quality (IEQ) ***IEQ Credit 4.1 Low-Emitting Materials: Adhesives & Sealants*** Projects shall receive one point if all adhesives and sealants used on the interior of the building comply with South Coast Air Quality Management District (SCAQMD) Rule #1168. ***IEQ Credit 4.3 Low-Emitting Materials: Carpet Systems*** Milken carpet products are certified by the Carpet and Rug Institute's Green Label Plus program.
Innovation in Design Credits (ID) Milken Commercial Carpet is NSF 140 and SMaRT certified. Milken Carpet is also third party certified as Carbon Neutral Products certified to third party standards for sustainability can qualify for innovation point credits.



	WHY CHOOSE MILLIKEN CARPET	LEED POINTS FOR YOUR PROJECT
MR 2.1 / 2.2	100% of your old carpet can be diverted from landfill via Milliken Reclaim Program.	Contributes to 1 point
MR 4.1 / 4.2	All Milliken Carpet contains a minimum of 24% recycled content.	Contributes to 1 point or 2 points with ESP products
MR 5.1 / 5.2	All Milliken carpet is manufactured in LaGrange GA.	Contributes to 1 point for projects within 500 miles of LaGrange GA
EQ 4.1	Milliken TractionBack, and all Milliken standard adhesives are compliant with SCAQMD #1168.	Contributes to 1 point
EQ 4.3	All Milliken Carpet Products are certified to the CRI Green Label Plus program.	Awarded 1 Full Point
INNOVATION	Milliken Carpet is NSF140 and SMaRT certified. All Milliken products are third party certified as carbon neutral.	Can contribute to up to 4 points

INTERFACEFLOR: Interface Carpets



Biobased Materials:
Our research into renewable materials led us to explore fibers made from polylactic acid (PLA), flax, hemp and wool. As we continue to explore the use of these materials, we will need to consider their complete impacts – particularly their relation to genetically modified organisms (GMOs) and food supplies, and the agricultural practices used to produce them. While current biobased products may not be the final answer in our quest for renewable fibers, they are a significant step in the right direction.

Recycled Materials:
Interface has significantly increased the recycled content in our products, both post-industrial and post-consumer, since we began our Mission Zero journey. Over the past few years however, we have made significant strides as a result of the ReEntry® and Cool Blue™ processes described below. Our current technologies allow us to manufacture product with 64-75% total recycled content, including more than 30% post-consumer recycled content.

An example of our use of post-industrial recycled materials is the replacement of virgin calcium carbonate (limestone) with aluminosilicate glass (ASG) in our carpet tile backing. ASG is a coal combustion byproduct (CCB) produced during the production of electricity at coal-fired power plants. Using ASG not only decreases the amount of virgin materials we use, but it also reduces the impact on landfills that would normally receive these CCBs.

Water Use
Interface has drastically reduced its water use through process changes and fixture replacement. The water intensity of our manufacturing process is relatively low, particularly for our modular carpet operations. While our broadloom manufacturing operations consume the largest amount of water at Interface, the facility has been shifting to a less water intensive yarn dyeing process, resulting in significant reductions. As of 2010, we decreased our water intake per unit of product by 82% since 1996.

ReEntry®

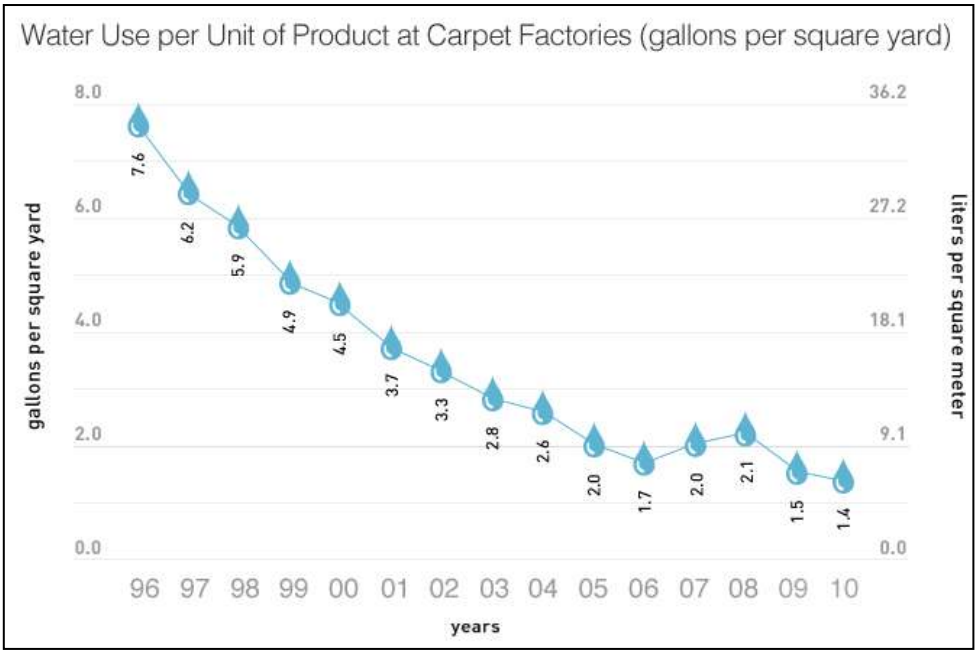
In 2007, Interface became the first carpet manufacturer to implement a process for the "clean separation" of carpet fiber from backing, allowing for a maximum amount of post-consumer material to be recycled into new products with minimal contamination. Through a process called ReEntry® 2.0, clean, post-consumer Nylon 6,6 fiber is returned to Interface's fiber supplier where it, in combination with some virgin materials, is recycled into new Nylon 6,6 for use in new carpet fiber. At the same time, the backing material is crumbled and transformed into new backing using our Cool Blue™ backing technology. Plastics that cannot be used for Interface processes or products are distributed to other industry suppliers for re-use in their material streams.

The ReEntry 2.0 process has lower embodied energy than other recycling systems in the carpet industry today. It will keep more carpet out of landfills, while providing a steady stream of post-consumer recycled materials across the industry.

Supply Chain

We quickly learned that the substantial majority of our product's footprint was incurred before our raw materials reached our receiving docks. It became clear to us that for Interface to be completely sustainable, we need to educate and actively engage our suppliers on our Mission Zero journey.

We began with Supplier Summits – conversations with our key suppliers to introduce them to our mission and sustainability goals. Today, we collaborate closely with our core strategic suppliers to address their own environmental impacts and, specifically, the impacts of the products they supply to Interface. This collaboration has resulted in solutions ranging from small steps to reduce our climate impacts to new and innovative technologies that increase the recycled content of our products.



DUPONT: DuPont Sonora Commercial Carpet

Sorona® renewably sourced™ polymers			
	Our Product	Conventional Product	Substitute Product
BACKGROUND INFORMATION			
Product Name	DuPont™ Sorona® renewably-sourced polymer	PTT-01	Nylon
Chemical Name	poly(trimethylene terephthalate)	poly(trimethylene terepthalate)	polyamide (Type 6)
Major Uses	Textile & carpet fibers	Textile & carpet fibers	Textile & carpet fibers
DuPont Manufacturing Location	Kinston, SC, USA; Jiangsu, China (DuPont licensee Zhenjijiang Glory)	n/a	n/a
CRADLE-TO-GATE MANUFACTURING PARAMETERS			
Greenhouse Gas Emissions kg CO2 equivalents/kg	3.38 [1, 2]	Propylene route: 4.42 [1] Ethylene oxide route: 4.04 [3]	9.1 [4]
Non Renewable Energy Consumption MJ/kg	83.8 [1, 5]	Propylene route: 101.2 [1,5] Ethylene oxide route: 94.6 [3]	120.5 [4,5]

PRODUCT PROPERTIES

Renewable content % by weight	37%	0%	0%
Biobased Carbon Content % by weight [6]	28%	0%	0%
Biodegradability [7]	n/a	n/a	n/a
Compostability [8]	No	No	No
Other Information	Recyclability of Sorona® in the PETE waste stream is being established via Association of Postconsumer Plastic Recyclers (APR) guidelines		

References

1 Peer-reviewed LCA of Bio-PDO / Sorona production (Peer reviewer: Prof. Konrad Saur, Five Winds International)

2 includes bio-based carbon stored in product

3 G. Elliott, L. Cisneros, R. Ramachandran "A Life Cycle Assessment of Corterra Polymer" (May 12, 2005)

4 PlasticsEurope (March 2005), A. Boustead, Ecoprofiles of the European Plastics Indusrty, Polyamide 6 (Nylon 6) (www.lca.plasticseurope.org/)

5 based on higher heating values (HHV)

6 ASTM Standard D 6852: Standard Guide for Determination of Biobased Content, Resources Consumption, and Environmental Profile of Materials and Products

7 ASTM Standard E1720 Standard Test Method for Determining Ready, Ultimate, Biodegradability of Organic Chemicals in a Sealed Vessel CO2 Production Test

8 ASTM Standard D6400 Standard Specification for Compostable Plastics

DuPont™ Renewably Sourced™ Materials contain a minimum of 20% renewably sourced ingredient by weight.

- **PAINT PROVIDERS**
  PPG ARCHITECTURAL COATINGS: Porter Paints & Pure Performance®

UNDERSTANDING USGBC LEED® 2009

The United States Green Building Council (USGBC), through its Leadership in Energy and Environment Design (LEED®), is the nationally accepted benchmark rating system for the design, construction and operation of high-performance green buildings.

Your paint choice contributes to USGBC LEED® certification. PPG Architectural Coatings, through its PPG, PPG Pittsburgh Paints®, and PPG Porter Paints® brands can help you earn USGBC LEED® points with a wide range of green paint products.

LEED NC: New Construction & Major Renovations 2009

The LEED for New Construction Rating System is intended to direct and recognize high-performing commercial and institutional projects, including office buildings, high-rise residential buildings, government buildings, recreational facilities, manufacturing plants and laboratories.

Paint VOC Required (EQ Credit 4.2-1 point):

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

LEED CI: Commercial Interiors

LEED for Commercial Interiors is the green standard for tenant improvements. It is the accepted method for certifying high-performance interiors that promote health, productivity; cost savings; and a reduced environmental footprint. LEED for Commercial Interiors empowers tenants and designers to make sustainable choices in cases where they may not have control of total building operations.

Paint VOC Required (EQ Credit 4.2-1 point):

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

LEED CS: Core & Shell Development

LEED for Core & Shell is a high-performance rating system for designers, builders, developers and new building owners who want to undertake sustainable plans for new core and shell construction. Core and shell covers basic building components such as structure, envelope, and HVAC. LEED for Core & Shell is intended to be complementary to LEED for Commercial Interiors, as both rating systems establish building performance green criteria for developers, owners and tenants.

Paint VOC Required (EQ Credit 4.2):

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

LEED for Homes

A LEED-certified home is designed and built in conformity with the thorough guidelines of the LEED for Homes green rating system. LEED for Homes is a cooperative, third party- confirmed, voluntary certification program which encourages the design and construction of high-performance green homes.

Paint VOC Required:

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

LEED for Schools

The LEED for Schools Rating System realizes the distinctive nature of the design and construction of K-12 schools. Derived from the LEED for New Construction rating system, it tackles issues such as classroom acoustics, master planning, mold prevention and environmental site assessment. By focusing on the distinctiveness of schools and the health issues of children, LEED for Schools provides an exclusive, across-the-board tool for schools that want to build sustainably, with quantifiable results.

Paint VOC Required (EQ Credit 4.2- 1 point):

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

BEHR: Premium Plus Interior Paints & Primers
Premium Plus Ultra Interior Paints

BEHR PREMIUM PLUS® Interior Flat

- Low Odor, Zero VOC*
- Self-Priming: Seals Uncoated and Previously Painted Surfaces
- Easy-Clean Flat
- Non-Reflective Matte Appearance
- Excellent Touch-Up
- Ultimate Durability
- Exceptional Hide
- 100% Acrylic
- Mildew Resistant Finish
- Lifetime Guarantee*

No. 1050 Ultra Pure White®
No. 1012 Swiss Coffee
No. 1052 White
No. 1070 Linen White
No. 1300 Deep Base
No. 1400 Medium Base

1 Hr Dry Time
2 Hr Recoat Time

250-400 Sq. Ft. Coverage per Gallon

Soap & Water Clean-Up

Protect from Freezing

FOR TINT BASES – DO NOT USE WITHOUT THE ADDITION OF TINTING COLORANTS

WHERE TO USE

For low traffic areas. Ideal for Family Rooms, Living Rooms, Dining Rooms, Bedrooms and Ceilings.

PREPARATION

All surfaces should be properly prepared and cleaned. Remove loose paint, wash off dirt and grease with detergent, rinse and allow to dry. Remove mildew stains with a mildew stain removing product. Scuff sand glossy surfaces and repair imperfections. Remove all dust with a damp cloth, allow to dry. Allow new stucco, plaster and masonry to cure for 30 days before painting.

PRIME

BEHR PREMIUM PLUS® paint is self priming over properly prepared uncoated and previously painted Interior surfaces. On stains, over oil-based coatings or glossy surfaces, use a product such as BEHR PREMIUM PLUS® Stain-Blocking Primer & Sealer No. 75. For optimal color development, better hide, and to reduce the number of topcoats with deep colors denoted with a dagger (†) on the color chip, apply a custom tinted primer.

APPLICATION

Apply when air and surface temperatures are between 50-90°F (10-32°C). Stir paint occasionally. Intermix containers of same product to ensure color and sheen uniformity. Use a high quality 3/8-1/2" nap roller cover, nylon/polyester brush or airless sprayer (.015-.019" spray tip, 60 mesh filter). Do not thin if using a roller or brush; however, if using a sprayer and thinning is required, thin with water at a rate of no more than 1/2 pint per gallon. Certain colors may require more than one coat for complete hide. Darker colors may require additional dry time between coats. Cooler temperatures or higher humidity may prolong drying time. After 4 weeks, cured paint film may be cleaned with a mild, non-abrasive liquid detergent. Dry paint film is mildew resistant.

DISPOSAL

For disposal of empty containers, unused paint and soiled rags, contact your household refuse collection service.

Visit behr.com for painting tips, expert project advice and the perfect color coordination with COLORSMART BY BEHR™.

WARNING! If you scrape, sand or remove old paint, you may release lead dust. LEAD IS TOXIC. EXPOSURE TO LEAD DUST CAN CAUSE SERIOUS ILLNESS, SUCH AS BRAIN DAMAGE, ESPECIALLY IN CHILDREN. PREGNANT WOMEN SHOULD ALSO AVOID EXPOSURE. Wear a NIOSH approved respirator to control lead exposure. Clean up carefully with a HEPA vacuum and a wet mop. Before you start, find out how to protect yourself and your family by contacting the National Lead Information Hotline at 1-800-424-LEAD or log on to www.epa.gov/lead.

BEHR PREMIUM PLUS ULTRA®
Interior Flat Enamel

- Paint & Primer in One
- STAYS LOOKING NEW LONGER® Finish
- Scuff Resistant Finish
- Mildew Resistant Finish
- 100% Acrylic Latex
- Easy-Clean Low-Lustre Matte Sheen
- Low VOC

No. 1750 Ultra Pure White®
No. 1752 White
No. 1753 Deep Base
No. 1754 Medium Base

IMPORTANT: DO NOT OPEN CAN WITHOUT READING THESE INSTRUCTIONS. PROTECT FROM FREEZING.

FOR TINT BASES – DO NOT USE WITHOUT THE ADDITION OF TINTING COLORANTS

BEHR PREMIUM PLUS ULTRA® is a patent pending paint and primer in one coating that will change the way you paint. This exciting product features advanced NANOGUARD® technology with an extra-protective shell that offers excellent stain removal and resistance, outstanding water and scuff resistance, and great touch up, coverage and hide, creating an easy to clean STAYS LOOKING NEW LONGER® finish. It is ideal for use in high traffic areas and on surfaces where moisture, mildew, or fungus growth may be a problem. This sophisticated, hand-selected color palette delivers superior coverage in fewer coats.

WHERE TO USE

- Properly prepared coated and uncoated Interior surfaces. Ideal for Family Rooms, Living Rooms, Dining Rooms, Bedrooms, Hallways and Ceilings.

PREPARATION & PRIME†

- Remove loose paint, wash off any dirt and grease with detergent, remove mildew stains with a mildew stain removing product.
- Scuff sand glossy surfaces.
- Countersink nail heads, repair imperfections and sand smooth.
- Remove all dust with a damp cloth, allow to dry.
- Allow new stucco, plaster and masonry to cure for 30 days before priming.
- Use BEHR PREMIUM PLUS ULTRA as a primer for repaired or uncoated surfaces. Lock in stains with the first primer coat; if necessary, apply a second primer coat of BEHR PREMIUM PLUS ULTRA.
- For best performance with heavy stains and watermarks use a product such as BEHR ENAMEL UNDERCOATER PRIMER & SEALER NO. 75.
- For drastic color changes, apply a primer coat of BEHR PREMIUM PLUS ULTRA if needed.

APPLICATION

- Use product when the surface and air temperatures are between 50-90°F (10-32°C).
- Stir paint occasionally. Intermix containers of same product to ensure color and sheen uniformity.
- Use a high quality 3/8-1/2" nap roller cover, nylon/polyester brush or an airless sprayer (.015 - .019" spray tip, 60 mesh filter).
- Coverage is 250-400 sq. ft. (23-37 m^2) per gallon depending on the surface texture, porosity and application method.
- Do not thin if using a roller or brush; however, if using a sprayer and thinning is required, thin with water at a rate of no more than 1/2 pint per gallon.
- Certain colors may require more than one coat for complete hide.

DRY TIME

- Dries to touch in 2 hours at 77°F (25°C) and 50% humidity, re-coat in 4 hours.
- Longer dry time required in cooler temperatures and in higher humidity.
- After 4 weeks, cured paint film may be cleaned with a mild, non-abrasive liquid detergent.
- Dry paint film is mildew resistant.

CLEAN-UP & STORAGE

- Use soap and water.
- Properly dispose of all soiled rags and **protect unused product from freezing**.
- For disposal of empty containers and unused product, contact your household refuse collection service.

Refer to the BEHR Interior Paint Guide for additional tips or visit us at behr.com for expert project advice and perfect color coordination with COLORSMART BY BEHR™.

† **WARNING!** If you scrape, sand or remove old paint, you may release lead dust. LEAD IS TOXIC. EXPOSURE TO LEAD DUST CAN CAUSE SERIOUS ILLNESS, SUCH AS BRAIN DAMAGE, ESPECIALLY IN CHILDREN. PREGNANT WOMEN SHOULD ALSO AVOID EXPOSURE. Wear a

- **WOOD FLOORING PROVIDERS**
  RESYSTA: Resysta Aged Teak

»Resysta is extremely resistant and features an excellent eco-balance «

Technical and ecological assessment of the new material Resysta:

Resysta looks like wood and stands out for its high mechanical strength, thermal stability as well as **chemical resistance. Unlike wood, Resysta is swell-, splinter- and crack-free, does not gray or fade** and withstands pest infestation. Resysta products are therefore **very durable** without requiring special care or maintenance. Resysta is **a true alternative to tropical wood.**

It is therefore especially suitable for outdoor use like garden furniture and outdoor decking as well as for wellness and pool areas, where high strain, aggressive weather, temperature and environmental influences take effect. Resysta products furthermore provide for an exceptionally beneficial eco-balance. In short: **Resysta deserves the title »The better wood« in every sense.**

...PRODUCT PROPERTIES
- UV-resistance
- weather resistance
- water resistance
- salt- and chlorine-water resistance
- no cracking
- no pest infestation or fungal decay
- flammability classification B2 (with additives, B1 classification possible)

...SURFACE AND DESIGN
- wood feel and appearance
- skid resistance
- no splintering
- individual color scheme


... HANDLING
• easy installation
• customary tools
• easy to refinish
...SUSTAINABILITY
• no rotting
• 100% recyclable
• easy-care


Resysta Color Concept - FVG glazes
C 02
C 08
C 14
C 23
C 24
C 26
C 28
C 29
C 42
C 45
C 46
C 47
C 49
C 51
C 52
C 53
C 3001
C 3011
C 5010
C 6002
C 9005

Density	ASTM D2395:2002	approx.1.46 kg/m³
Coefficient of Linear Thermal Expansion	ASTM D696	3.6x10(-5)mC
Water Absorption and Air Humidity Behaviour	ASTM D1037:2006a	none or very low water absorption (only surface wetting)
Weathering and UV Resistance	QUV Test	Resysta surfaces treated with glaze show extremely high resistance
Skid Resistance	DIN 51097	C Rating (highest rating)
Fire Behaviour (German Standard)	EN ISO 11925-2	B2, normal flammability (by adding flame retardants, a higher rating of B1 can be reached)
Fire Behaviour (US Standard)	NFPA	A Rating (flame propagation 25, smoke emission 450)
Fire Behaviour (British Standard)	BS 476 Teil 6&7	Rating 1
Durability (Resistance to Wood-Destructive Fungi)	DINV ENV 12038:2002	the material has not been affected, highest durability – Class 1
Emission	DIN EB ISO 9001/14001	passed
Brinell Hardness (HB)	EN 1534	81,1 N/mm²
Friction Coefficient μ untreated	EN 13893	0,46
Friction Coefficient μ with 2K	EN 13894	0,52

Globally renowned institutions carry out tests according to German, British, European and US standards.

RECITEC: Compuesto de Fibra de Plástico

Productos versátiles y confiables

¿Que és la fibra Plástica?

El Compuesto de FIBRA PLASTICA constituye un nuevo material, resultado de muchos años de investigación y desarrollo de materiales eficientes y amigables con el medio ambiente. Esta hecho a base de fibras naturales, resinas plásticas y aditivos especiales, utilizando en su fabricación la más alta ingeniería en mezclas de polímeros, así como diseño e ingeniería auxiliados por computadora (CAD/CAE); dando como resultado, un material altamente resistente al impacto, de gran rigidez y larga vida.

Las fibras naturales que pueden ser utilizadas incluyen: harina de madera y algunas fibras agrícolas, tales como cascarilla de arroz, cáscara de nuez, cáscara de coco, bagazo de café, etc.

En cuanto a los materiales plásticos, principalmente se utiliza Polietileno de Alta Densidad (PEAD), pero también puede usarse Polietileno de Baja Densidad (PEBD), Polipropileno (PP), PVC , ABS y Poliestireno.

¿Cuales son las características de la fibra plástica?

- Tiene propiedades físicas superiores a la madera natural.
- Es un material de gran duración, que mantiene sus características originales y no requiere ningún tipo de mantenimiento.
- Se puede cortar, atornillar, clavar, taladrar, y en general trabajar como la madera con las mismas herramientas.
- Se pueden fabricar perfiles en formas y medidas muy diversas, tales como: sólidos, huecos (cerrados y abiertos),espumados, con recubrimientos, etc.
- Por sus propiedades únicas, la FIBRA PLÁSTICA puede sustituir a la madera natural y en algunas aplicaciones a metales tales como aluminio y acero.

PROPIEDADES FÍSICAS DEL COMPUESTO DE FIBRA PLÁSTICA

Propiedad	Unidad	Método	Valor
Densidad	g/cm 3	GSX	1.1
Coeficiente de expansion térmica lineal-Ref20 oC	mm/mm/ oC	GSX	3.5E-05
Absorción de humedad	%	GSX	0.1%
Absorción de agua (24 hrs)	%	ASTM D570	0.2%
Absorción de agua con superficie rugosa (24 hours)	%	ASTM D570	0.3%
Prueba de flama	second	UL-94-V-0	0
Deterioro por radiación UV	mm/year	GSX	0.050

PROPIEDADES MECÁNICAS DEL COMPUESTO DE FIBRA PLÁSTICA

Propiedad	Unidad	ASTM	Mínimo	Máximo
Elongación a la ruptura	%	D790-92	3.6	4.2
Modulo de flexión	psi	D790-92	454,000	615000
Esfuerzo de flexión	psi	D790-92	7,100	7600
Módulo de compresión	psi	D790-92	170,000	260000
Esfuerzo de compresión	psi	ASTM D570	4,300	5700
Resistencia al impacto izod (sin ranura)	ft-lb/in	UL-94-V-0	1.06	1.16
Fuerza para desprender el tornillo (taladro piloto de 11/64",1"prof.)	lb	GSX	753	5 mm screw

- **CERAMIC TILES PROVIDERS**
  INTERCERAMIC: Ceramic Flooring Tiles

Productos Cerámicos y El Medio Ambiente

Ciclo de Vida
La loseta de cerámica y el piso porcelánico son productos de recubrimiento para pisos con la más larga duración en el mercado actual. A diferencia de las alfombras, el vinilo y los pisos laminados (los cuales tienen que ser reemplazados periódicamente), un piso de cerámica adecuadamente instalado puede durar toda la vida.

Calidad de Aire en Interiores
Este es un tema muy actual y por una buena razón. Los compuestos orgánicos volátiles (VOC's) ocasionan un sin fin de problemas de salud ya que son causa principal del "síndrome del edificio enfermo". Debido a que la cerámica pasa por un proceso de cocimiento a temperaturas extremadamente altas, no se presentan en el producto terminado compuestos orgánicos volátiles que puedan ser liberados en el aire que respiramos; siendo literalmente "CERO". Adicionalmente para su instalación, se encuentran disponibles adhesivos y boquillas que contienen CERO o con una cantidad muy pequeña de "VOC's". Aunque algunas alfombras, piso de vinilo o piso de madera contienen muy bajos niveles de compuestos organicos volatiles, nunca llegaran a CERO.

Reciclado
Actualmente las plantas productoras de cerámica se están enfocando en el reuso de agua y materiales. Logrando enviar cantidades muy pequeñas de residuos a confinamiento y desperdicio de agua a plantas tratadoras.

Disponibilidad Regional
Los productos cerámicos y de instalación son fabricados con materiales locales que se encuentran ampliamente disponibles, a diferencia de otras alternativas para recubrimientos de pisos, en las cuales los fabricantes tienen que transportar su productos miles de kilómetros para que el producto pueda llegar al cliente.
La disponibilidad regional contribuye a la reducción de consumo de energía y combustible, así como emisiones de contaminantes al ambiente asociadas con la transportación de estos productos al lugar del proyecto de construcción.

Hipoalergénicos
La loseta cerámica previene la formación de hongos o bacterias ya que es usada frecuentemente para reemplazar a otros materiales de recubrimiento de pisos tales como alfombras previniendo así alergias o asma en las personas.

Fácil Mantenimiento
A diferencia de otros materiales que requieren químicos y limpiadores con base de solventes, nuestros productos tienen la ventaja de que se pueden limpiar fácilmente utilizando materiales de limpieza a base agua.

Leed®

LEED® (Liderazgo en Energía y Diseño Ambiental) es un programa desarrollado por el U.S. Green Building Council (USGBC) que ha ganado reconocimiento en el mercado comercial e institucional. El programa LEED® ha desarrollado un sistema de puntos para construcción de edificios verdes que permite a los constructores y propietarios de los mismos, evaluar el impacto del diseño o energía utilizada en el proyecto de acuerdo a aspectos ambientales. Se pueden obtener puntos para lograr la certificación LEED® en un proyecto como resultado de diferentes alternativas que se toman al momento de diseñar, construir y operar un edificio nuevo, uno ya existente, una renovación, o diseño de interiores en escuelas o comercios.

Ningún producto puede obtener la Certificación LEED®, solamente los edificios pueden ser certificados. Sin embargo Los productos cerámicos pueden contribuir a la obtención de puntos en proyectos de construcción para lograr la certificación LEED®.

La loseta de cerámica contribuye a la certificación LEED® de la siguiente manera:

- Contenido de Materiales Reciclados (MR Crédito 4)
- Materiales Regionales (MR Crédito 5)
- Baja emisión de Material (Compuestos Orgánicos Volátiles) (IEQ Crédito 4.3)
- Efecto Isla de Calor (SS Crédito 7.1)
- Pueden existir formas adicionales que contribuyan a la obtención de puntos LEED®. Consulta a un profesional acreditado LEED®.

Al usar las series Interceramic puedes obtener hasta un máximo de 6 posibles puntos LEED® si el proyecto cumple con:

MR Crédito 4	Contenido de reciclado	10%	1 Punto
	Contenido de reciclado	20%	2 Puntos
IEQ Crédito 4.3	Baja Emisión de Material	Contenido de Compuestos Orgánicos Volátiles (VOC's)	1 Punto
MR Crédito 5	Materiales Regionales	10% extraído, procesado o manufacturado regionalmente	1 Punto
	Materiales Regionales	20% extraído, procesado o manufacturado regionalmente	2 Puntos
SS Crédito 7.1	Efectos Isla de Calor	SRI >29; Color de la cerámica	1 Punto

Otros estándares y lineamientos ambientales importantes se encuentran actualmente en desarrollo, tal es el caso de NABH National Association of Home Builders, The Collaborative for High Performance Schools, Green Globe y otras. La loseta de cerámica producida en Norte América contribuye a proporcionar un largo ciclo de vida, calidad de aire en interiores y beneficios regionales de fabricación a todos ellos.

El TCNA-Tile Council of North America (Consejo de Cerámica de Norte América es miembro de U.S. Green Building Council).

LAMOSA: Porcelanite Ceramic Tiles

Descubriendo Green Matters

Green matters. está enfocado al desarrollo de productos y servicios para ayudar a nuestros clientes en sus iniciativas y proyectos de construcción sustentable para reducir el impacto ambiental.

Durable

Los revestimientos cerámicos de Porcelanite-Lamosa durarán varias generaciones. Su larga vida y belleza permanente son la mejor razón del porqué es la mejor alternativa comparada con otros materiales de recubrimientos.

Ecológico

Nuestro proceso de manufactura utiliza grandes porcentajes de materiales reciclados (agua, material de proceso, calor de equipos) en todas las fases de producción. Además, Porcelanite-Lamosa prefiere adquirir productos de proveedores que utilicen porcentajes considerables de materiales reciclados en sus operaciones como papel y cajas.

Construcción verde - Contribución LEED

El revestimiento cerámico es la mejor opción de recubrimientos al construir sustentablemente.

El usar los productos de Porcelanite-Lamosa tendrá un potencial de contribución dentro de varias categorías de créditos LEED:

• **Crédito MR 1.2:** Construcción re-usable - mantener elementos interiores no estructurados. El re-uso de paredes, pisos y techos con revestimiento cerámico de antiguos propietarios puede contribuir enormemente a la adquisición de este crédito LEED.

• **Crédito MR 3:** Re-uso de materiales: Los productos de Porcelanite-Lamosa pueden recuperarse y colocarse en una nueva instalación para diferentes propósitos como recubrimiento de pisos y paredes, cubiertas, muebles y en piezas de decoración estilo mosaico.

• **Crédito MR 5:** Materiales regionales: Los materiales Porcelanite-Lamosa se encuentran frecuentemente disponibles alrededor de 800 Km de los proyectos de nuestros clientes.

• Crédito IEQ 3.1: Plan de manejo de construcción de la calidad del aire interior - durante la construcción. El uso de revestimiento cerámico puede simplificar el plan de manejo de la calidad del aire interior y por ende simplifica la adquisición de este crédito LEED.

• **Crédito IEQ 3.2:** Plan de manejo de construcción de la calidad del aire interior -antes de la ocupación. Una vez instalado, los productos de Porcelanite-Lamosa tienen un mayor efecto positivo en la calidad del aire interno que las superficies de recubrimientos de la competencia.

• **Crédito IEQ 4.3:** Materiales de baja emisión - sistemas de pisos: El revestimiento cerámico de Porcelanite-Lamosa es un material inerte que no emite compuestos orgánicos volátiles (VOC's).

- **CONCRETE FLOOR FINISHES**
  CORNERSTONE FLOORING DE MEXICO: Polyurethane & Polymer Flooring

Polyurethane & Polymer Flooring

Polyurethane flooring systems are high performance polymer materials with exceptional properties. Polyurethane flooring systems are designed to be durable and resilient and are engineered for applications where thermal, chemical or impact resistance are considerations. Polyurethane flooring systems offer low odor, low VOC installations and are designed to be non-porous while closely matching the same co-efficient of expansion as concrete. Contact a Corner*Stone*™ technical representative to find out more information about our polyurethane flooring systems or click a link below.

Polyurethane & Polymer Flooring Systems:

- CS 5000SB CornerCrete™ Slurry Matrix Polyurethane Flooring System
- CS 5000SB Q CornerCrete™ Slurry Matrix Decorative Quartz Polyurethane Flooring System
- CS 5000T CornerCrete™ Trowel Matrix Polyurethane Flooring System
- CS 5000F BioFloor Heavy Duty Decorative Paint Flake Polyurethane Flooring System

Green Building and LEED Certification

Corner*Stone*'s products can help architects and building contractors to achieve LEED Certification. We strive to employ the best performing and longest lasting solutions. This in turn equals better solutions for the environment.

LEED Credits Summary	Potential Points
Sustainable Sites	
SS Credit 4.2: Alternative Transportation - Bicycle Storage & Changing Rooms - Corner*Stone* Flooring can contribute by providing waterproof membranes and skid resistant finishes where necessary to assist with safety.	1

Sustainable Sites SS Credit 4.3: Alternative Transportation - Low Emitting & Fuel Efficient Vehicles - Corner*Stone* Flooring can contribute by providing chemically resistant coatings and linings where onsite fuel containment and protection is needed.	1
Water Efficiency WE Credit 2: Innovative Wastewater Technologies - Corner*Stone* Flooring can contribute by providing primary and secondary containment systems to capture various liquids and contaminants.	1
Energy & Atmosphere EA Credit 1: Optimize Energy Performance - Corner*Stone* Flooring can contribute by providing the option of floor and wall gloss finishes for greater reflectivity allowing for the use of lower wattage lighting.	1

Materials & Resources MR Credit 1.2: Building Reuse, Maintain 50% of interior non-structural elements	1-2
Materials & Resources MR Credit 5: Regional Materials, 10% to 20% Extracted, Processed & Manufactured Regionally - Corner*Stone* Flooring assembles our materials on site and manufactures at facilities within 500 miles of many project sites.	1
Indoor Environmental Quality EQ Credit 3.1: Construction IAQ Management Plan During Construction - Corner*Stone* Flooring can employ the use temporary air handlers and filtration media to assist with developing and implementing an Indoor Air Quality (IAQ) Management Plan.	1
Indoor Environmental Quality EQ Credit 4.2: Low-Emitting Materials, Paints & Coatings - Corner*Stone* Flooring can provide low odor and low/zero VOC flooring systems with low to zero off-gassing.	1

CURECRETE: Ashford formula

TECHNICAL DATA
Product Description: Colorless, Odorless, Non-toxic, Non-combustible, Non-flammable Contains no Volatile Organic Compounds (VOCs)
Uses: Concrete, new and old, rough or smooth surfaces Concrete Block Exposed Aggregate, Any Sand/Aggregate Cement Combinations
Functions: Seals, dust proofs, hardens, and cures. Protects against dusting, pitting, palling, efflorescence, temperature cracking in concrete. Inhibits freeze/thaw deterioration. Neutralizes excess internal alkali from concrete
Packaging: 55 Gallon Drum/208 Liters 5 Gallon Pail/19 Liters
Storage Life: Two years. Agitate drum or pail before using.
Surface Preparation: Freshly Finished Concrete: no preparation required. Existing Concrete: sweep, scrub, or strip concrete to remove any surface contamination or film. Product must be able to penetrate the surface without hindrance.
Application: Single application only. Apply with low-pressure sprayer (power), rollers, brush, or fine/soft bristled broom.
Coverage Rate: Approximately 200 square feet per gallon; 5 meters per liter.
Drying Time: One to three hours.
Appearance After Application: Smooth Troweled Concrete: permanent, marble-like sheen develops within 4-12 months. Burnishing the concrete surface with a propane burnisher will accelerate the sheen. All Other Concrete Surfaces: retention of natural finish.
Temperature Limits: Applicable in temperatures up to 135º F/57ºC or as low as 35ºF/1.7ºC if the concrete is covered by plastic and completely protected from freezing for a period of 6 days.
Thinners, Primers and Painting: No thinners or primers required. Painting on New Concrete: allow at least 7 drying days before applying Painting on Existing Concrete: allow 28 days for proper curing before painting
Colored Concrete: Apply to colored concrete only after the slab is fully cured. Do not get on glass or other finished surface.
Limitations: Do Not Apply the Ashford Formula to: Lightweight block or other extremely porous masonry containing actual holes or air pockets. Areas previously treated with curing or sealing agents, unless these coatings have completely worn off or have been removed by chemical or mechanical means.

- **ENVIRONMENTALLY FRIENDLY GRID CEILINGS**
  ARMSTRONG: Tierra

TIERRA™

Square Lay-in

fine texture

cradle to cradle SILVER

This commercial ceiling tile has been certified for its material content, recyclability, and manufacturing characteristics. c2ccertified.com

Rapidly Renewable: 44% armstrong.com/greengenie

LEED® Credits

Energy	Waste Mgmt	Local Materials	Renewable Materials	Daylight & Views
✔	✔		✔	✔

Location Dependent

LEED for Schools

Acoustics	Low Emitting or CHPS
✔	✔

$$$$$

Tierra Square Lay-in (2' x 2') with Suprafine® XL® 9/16" grid

Key Selection Attributes

- Natural, BioAcoustic™ substrate
- 44% rapidly renewable substrate made from jute, a plant that grows from seed to harvest in 100 days
- Tierra is listed as a USDA BioPreferred® product
- The first and only *Cradle to Cradle Certified™ Silver* acoustical ceiling panel
- Outstanding acoustical performance for open plan areas, both Articulation Class (180) and NRC (0.85)
- Smooth, clean, durable finish – Washable, Impact-resistant, Scratch-resistant, Soil-resistant
- Energy-saving high light-reflective finish
- Non-directional visual reduces installation time and scrap
- 30-Year Limited System Warranty against visible sag, mold/mildew, and bacterial growth

Typical Applications

- Open plan spaces:
  - Office
  - Education
  - Healthcare – assists in addressing HIPAA requirements and FGI Guidelines (walls-to-deck)
- Corridors (walls-to-deck)
- Auditoriums
- Areas with indirect lighting

Color

White (WH)

Visual Selection

Performance Selection

Dots represent highest level of performance.

Edge Profile	Item No.	Dimensions		UL Classified Acoustics NRC	CAC	AC	Fire Rating	Light Reflect	Sag Resist	Anti-Microbial	Durable: Wash	Impact	Scratch	Soil
TIERRA Square Lay-In														
9/16" Square lay-in	**3462**	2' x 2' x 5/8"	☐	0.85 •	N/A	180 •	Class A	0.88 •	HumiGuard+ •	BioBlock+ •	•	•	•	•
15/16" Square lay-in	**3460**	2' x 2' x 5/8"	☐	0.85 •	N/A	180 •	Class A	0.88 •	•	•	•	•	•	•

Suspension Systems

15/16" Prelude®

9/16" Suprafine

USG: Mars™ Clima Plus™ & Eclipse™ Clima Plus™

Sustainability Tables

USGBC LEED® credits		MR 4.1 & 4.2				EQ 8	EQ Pre 3 & EQ 9		
Product Family: Acoustical Panels and Tiles		Post-Consumer		Pre-Consumer		LR	NRC	CAC	Approx. Density (lbs/cft)
		Class A	FC	Class A	FC				
X-Tech.	Eclipse™ Clima Plus™	0%	0%	65%	69%	0.86	.65 / .70	35	17
	Millenia™ Clima Plus™	0%	0%	75%	62%	0.87	0.70	35	17
	Mars™ Clima Plus™	0%	NA	76%	NA	0.89	0.70	35	17

EQ 3.2 & EQ 4		MR 6	MR 5.1 / 5.2 & EQ 10
CHPS	Formaldehyde & VOC Emissions	Rapid Renew	Raw Materials / Comments (% by weight)
Pass	Low	1 - 2%	**X-Technology manufactured at Cloquet, MN.** Slag wool (Preconsumer %) from Red Wing, MN, 5% Acrylate Polymer (local), starch (Rapid Renew %) from Clinton, MN; Estimated embodied energy ~ 9kWh/SF for a 17 lb/cft 3/4" thick panel
		1 - 3%	
		2%	

Appendix 5: Energy's Annual Measurement and Verification Report Outline

Annual Report Outline

Contract #/ Delivery Order #/ Task#:
Performance period dates covered: _____to_____
Contract year #:

1. **Executive Summary**
   - **1.1 Project Background**
     - 1.1.1 Provide an overview of project background, including:
       - Contract #/ Delivery order #/ Task #/ Modification #
       - Dates of relevant delivery order modifications
       - Performance period dates covered
       - Project acceptance date
   - **1.2 Brief Project and ECM Descriptions**
     - 1.2.1 Provide an overview of what was done and how savings are generated
     - 1.2.2 Note any changes in project scope between the Final Proposal (including any relevant delivery order modifications) and as-built conditions as recorded in post-installation report.
   - **1.3 Summary of Proposed and Verified Energy and Cost Savings**
     - 1.3.1 Compare verified savings for Performance Year # to Guaranteed Cost Savings for Year #. State whether guarantee is fulfilled for year. If not, provide detailed explanation.
     - 1.3.2 Define performance period.
     - 1.3.3 Summarize information in Table 1 and Table 2.

Table 1. Proposed Annual Savings Overview
(Include all applicable fuels/ commodities, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.)

ECM	Total energy savings (MBtu/yr)	Electric energy savings (kWh/yr)	Electric demand savings (kW/yr)*	Natural gas savings (MBtu/yr)	Water savings (gals/yr)	Other energy savings (MBtu/yr)	Total energy & water cost savings Year# ($/yr)	Other energy related O&M cost savings, Year# ($/yr)	Total cost savings, Year# ($/yr)
Total Savings									
Year # guaranteed cost savings: $									

Notes:
MBtu= 10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings
If energy is reported in units other than MBtu, provide conversion factor to MBtu for link to delivery order schedules.
Guaranteed cost savings for project are defined in cost schedule DO-1 in delivery order.
The proposed savings for each ECM are included in schedule DO-4 in the delivery order.

Table 2. Verified Savings for Performance Year #

(Include all applicable fuels/ commodities, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.)

ECM	Total energy savings (MBtu/yr)	Electric energy savings (kWh/yr)	Electric demand savings (kW/yr)*	Natural gas savings (MBtu/yr)	Water savings (gals/yr)	Other energy savings (MBtu/yr)	Total energy & water cost savings Year# ($/yr)	Other energy related O&M cost savings, Year# ($/yr)	Total cost savings, Year# ($/yr)
Total Savings									

Year # guaranteed cost savings: $

Notes:
MBtu= 10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings
If energy is reported in units other than MBtu, provide conversion factor to MBtu for link to delivery order schedules.

1.4 Savings Adjustments

- Provide summary of any energy and/or cost savings adjustments required.

1.5 Performance and O&M Issues

- Note impact of operating deficiencies or enhancements on generation of savings.
- Note impact of maintenance deficiencies on generation of savings.

1.6 Energy, Water, and O&M Rate Data

1.6.1 Detail energy and water rates used to calculate cost savings for this period.
1.6.2 Provide performance period rate adjustment factors for energy, water and O&M cost savings, if used.
1.6.3 Report actual energy and water rates at site for same period (optional).

1.7 Verified Savings to Date

- Summarize information in Table 3.

Table 3. Verified Savings for Performance Period To Date

(Include all applicable fuels/ commodities, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.)

Year #	Total energy saving (MBtu/ yr)	Electric energy savings kWh/yr	Electric demand savings (kW/yr)*	Natural gas savings MBtu/yr	Water savings (gals/yr)	Other energy savings MBtu/yr	Total energy & water cost saving ($/yr)	Other energy related O&M cost savings, ($/yr)	Total cost saving ($/yr)	Guaranteed cost savings for year
Total Savings										

Notes:
MBtu= 10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings
If energy is reported in units other than MBtu, provide conversion factor to MBtu for link to delivery order schedules.

2. Details for ECM (name/#)

- Develop section for each ECM

2.1 Overview of ECM, M&V Plan, and Savings Calculation for ECM

2.1.1 Summarize the scope of work, location, and how cost savings are generated.
- Describe source of all savings including energy, water, O&M, and other (if applicable).

2.1.2 Discuss any changes in scope/ results recorded in post-installation M&V report.

2.1.3 State M&V guideline and option used.

2.1.4 Provide an overview of M&V activities for ECM.
- Explain the intent of M&V plan, including what is being verified.

2.1.5 Provide an overview of savings calculation methods for ECM.
- Provide a general description of analysis methods used for savings calculations.

2.2 M&V Activities Conducted on this Period

- Detail measurements, monitoring, and inspections conducted this reporting period in accordance with M&V plan.

2.2.1 Measurement equipment used.

2.2.2 Equipment calibration documentation.

2.2.3 Dates/times of data collection or inspections, names of personnel, and documentation of government witnessing.

2.2.4 Details to confirm adherence to sampling plan.

2.2.5 Include all measured values for this period. Include periods of monitoring and durations and frequency of measurements. (Use appendix and electronic format as necessary). Include description of data format (headings, units, etc.).

2.2.6 Describe how performance criteria have been met.

2.2.7 Note impact of performance deficiencies or enhancements on generation of savings.

2.3 Verified Savings Calculations and Methodology

2.3.1 Provide detailed description of analysis methodology used.
- Describe any data manipulation or analysis that was conducted prior to applying savings calculations).

2.3.2 Detail all assumptions and sources of data, including all stipulated values used in calculations.

2.3.3 Include equations and technical details of all calculations made. (Use appendix and electronic format as necessary). Include description of data format (headings, units, etc.).

2.3.4 Details of any baseline or savings adjustments made.

2.3.5 Detail energy and water rates used to calculate cost savings.
- Provide performance period energy & water rate adjustment factors, if used.
- Report actual energy and water rates at site for same period (optional).

2.3.6 Detail verified savings for this energy conservation measure for performance year.
- Include Table 4.

2.4 Details of O&M and Other Savings (if applicable)

2.4.1 Describe source of savings, if applicable.
- Describe verification activities.
- Provide performance period O&M savings adjustment factors, if applicable.

2.4.2 Describe source of other savings, if applicable.
- Describe verification activities.
- Provide performance period adjustment factors, if applicable.

Table 4. Verified Annual Savings For ECM for Performance Year #
(Include all applicable fuels/ commodities, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.)

	Total energy use MBtu/yr	**Electric energy use** kWh/yr	**Electric energy cost Year#** ($/yr)	**Electric demand *** (kW/yr)	**Electric demand cost Year#** ($/yr)	**Natural gas** MBtu/yr *	**Natural gas cost Year#** ($/yr)	**Water use** (gals/yr)	**Water cost Year#** ($/yr)	**Other energy use** MBtu/yr	**Other energy cost Year#** ($/yr)	**Other energy related O&M cost Year#** ($/yr)	**Total cost Year #** ($/yr)
Baseline use													
Performance Year# use													
Savings													

Notes:
MBtu= 10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings
If energy is reported in units other than MBtu, provide conversion factor to MBtu for link to delivery order schedules.

2.5 O&M and Other Activities

2.5.1 Operating requirements:
- State organization(s) responsible for equipment operations. If appropriate, detail how responsibilities are shared.
- Summarize key operating procedures and any related verification activities.
- Note impact of operating deficiencies or enhancements on generation of savings.

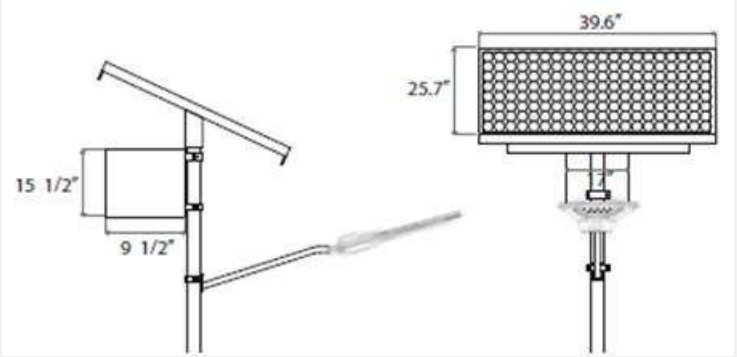
2.5.2 Preventive maintenance requirements:
- State organization(s) responsible for performing maintenance. If appropriate, detail how responsibilities are shared.
- Note impact of maintenance deficiencies on generating savings.

2.5.3 Repair and replacement requirements:
- State organization(s) responsible for repair and replacement. If appropriate, detail how responsibilities are shared.
- Note impact of maintenance deficiencies on generating savings.

Appendix 6: Eco-technologies Technical Specification

V. STREET LIGHTING

GRUPO ECOS: Photovoltaic Street Lighting

Lámpara de LEDs ECOKIT 2018	
Ventajas y Beneficios	
- Completamente autónomo - Más de 10 años de vida útil del sistema (excepto baterías) - Mínimo mantenimiento - Encendido y apagado automáticos - Fácil instalación	
	
Características	
Panel solar	Módulo FV de Silicio Cristalino
Lámpara	Lámpara de LED's ONILED 2018 de 12 VCD, 24 W, 1.9 A
Banco de baterías	Batería de gel ciclo profundo, sellada, libre de mantenimiento
Tempo-controlador	Controlador de carga FV con encendido automático
Autonomía sin recarga	3 días
Temperatura de operación	-25°C hasta +55°C
Color de la luz	Blanco frío 5000°-8000°K
Índice de rendimiento de color	>75
	

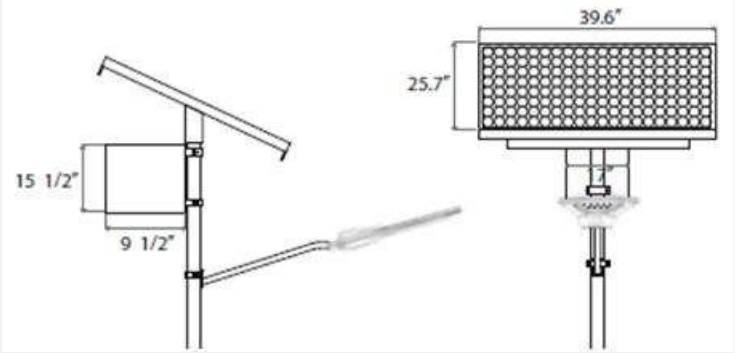
Lámpara de LEDs ECOKIT 2036

Ventajas y Beneficios

- Completamente autónomo
- Más de 10 años de vida útil del sistema (excepto baterías)
- Mínimo mantenimiento
- Encendido y apagado automáticos
- Fácil instalación

Características

Panel solar	Módulo FV de Silicio Cristalino
Lámpara	Lámpara de LED's ONILED 2036 de 24 VCD, 43.2 W, 2.1 A
Banco de baterías	Batería de gel ciclo profundo, sellada, libre de mantenimiento
Tempo-controlador	Controlador solar de carga FV con encendido automático
Autonomía sin recarga	3 días
Temperatura de operación	-25°C hasta +55°C
Color de la luz	Blanco frío 5000°-8000°K
Índice de rendimiento de color	>75



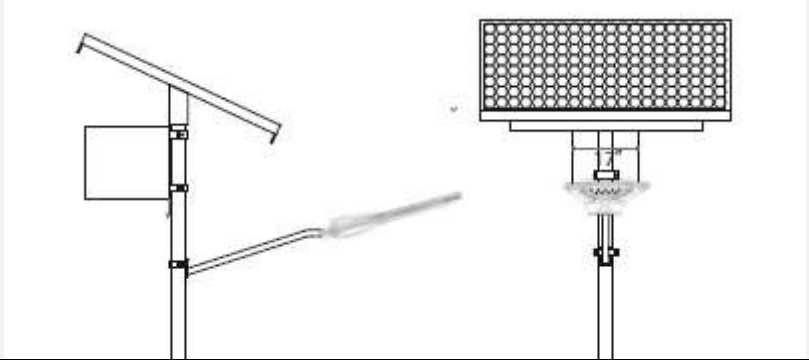
Lámpara de LEDs ECOKIT 2054

Ventajas y Beneficios

- Completamente autónomo
- Más de 10 años de vida útil del sistema (excepto baterías)
- Mínimo mantenimiento
- Encendido y apagado automáticos
- Fácil instalación

Características

Panel solar	Módulo FV de Silicio Cristalino
Lámpara	Lámpara de LED's ONILED 2054 de 24 VCD, 67W, 2.8 A
Banco de baterías	Batería de gel ciclo profundo, sellada, libre de mantenimiento
Tempo-controlador	Controlador solar de carga FV con encendido automático
Autonomía sin recarga	3 días
Temperatura de operación	-25℃ hasta +55℃
Color de la luz	Blanco frío 5000°-8000°K
Índice de rendimiento de color	>75



BIOCONSTRUCCIÓN Y ENERGÍA ALTERNATIVA: Hybrid Street Lighting

Arbotante Híbrido Solar-Eólico

El arbotante híbrido Solar-Eólico para alumbrado público es un sistema de iluminación inteligente, de baja escala y totalmente independiente a la red eléctrica. Está compuesto de módulos solares y una turbina de viento, baterías de ciclo profundo, un controlador y una lámpara LED para exterior.

El arbotante híbrido LED produce y almacena la energía proveniente del viento y el sol. No son necesarios cables al aire o bajo tierra. En el tope del poste, se encuentra la turbina eólica que cultiva la energía del viento de manera silenciosa, sin importar la dirección de choque. Junto con la turbina de viento se encuentra un panel solar en un brazo articulado que está óptimamente posicionado durante el proceso de instalación para obtener la mayor cantidad de irradiación solar. Toda la energía generada se almacena en la batería encontrada en la base del poste. La lámpara es de alta eficiencia LED que es tan brillosa y con la misma intensidad que una tradicional lámpara de vapor de sodio.

Características del Arbotante Híbrido Solar-Eólico

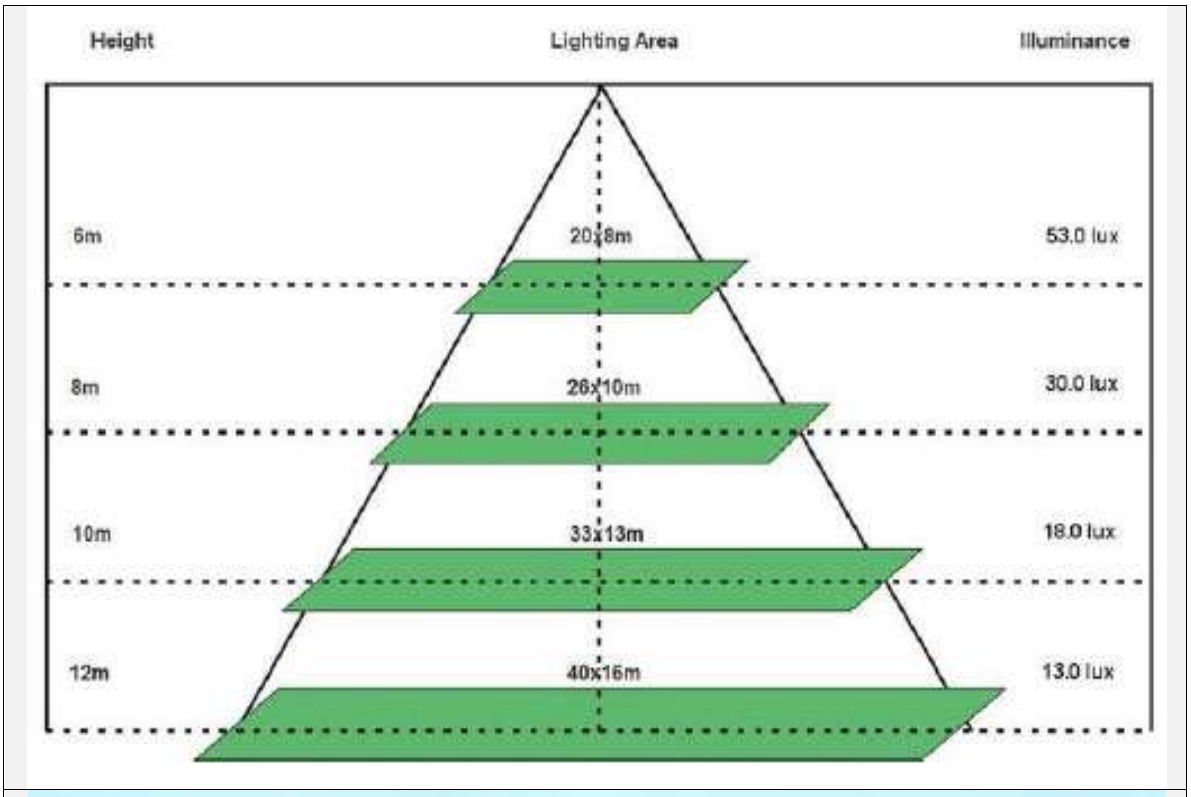
Arbotante Híbrido LED	SW120W, 24 VDC
Panel Solar	150 W policristalino (2)
Turbina de viento	600 W 24V
Batería	260 Ah, 12 V (2)
Controlador	600 W, 24 V, Controlador solar
Poste	6 m alto, acero galvanizdo
Período de funcionamiento	12 h/día, 3 días
Resistencia del viento	129 km/h
Aprovechamiento de energía diaria supuesta	3 horas

Características fotométricas de la lámpara LED

Factor de potencia	>.9
Voltaje de operación	24 VDC
Potencia lámpara LED	112 W
Eficiencia Luminosa LED	>80 lm/W
Flujo luminoso incial	10,000 lm
Flujo de la lámpara	8,400 lm
Área iluminada efectiva (6 m)	20m x 8m
Temperatura de color	Blanco Puro: 5,000-7,000; Blanco cálido: 3,000-4,000
Índice de color (CRI)	Ra>75
Vida de la lámpara	50,000 h

Características físicas del producto

Descripción	Peso (kg)	Dimensiones (mm)
Turbina eólica	27.5	1500 x 520 x 305
Controlador	1	1500 x 520 x 305
Panel fotovoltaico	30	1620 x 845 x 150
Lámpara LED 120 W	26	770 x 414 x 222
Batería	130	610 x 320 x 340


Height
Lighting Area
Illuminance
6m
20x8m
53.0 lux
8m
26x10m
30.0 lux
10m
33x13m
18.0 lux
12m
40x16m
13.0 lux

I. PHOTOVOLTAIC PANELS

BIOCONSTRUCCION Y ENERGIA ALTERNATIVA: Photovoltaic Panels

Xtp6_60 Photovoltaic Panel

Features

High module conversion efficiency
(Up to 14.97 %), through superior cell technology and religious quality control.

Positive tolerance
Guaranteed positive tolerance from 0 to 4%.

Splendid appearance
Meticulous systemized appearance control meeting the highest quality regulatory standards.

Low PID rate
Minimizing potential induced declaration rate with high glass transmission, low interconnected transmission loss and high EVA absorption rate.

Smart auto-recognition of weak light performance.
Smart light auto-recognition under the condition of low irradiance and hazy light (mornings, evenings and cloudy days)

Steady resistance to strong hailstone, wind and snow loads.
Special frame construction certified to ensure high wind loads (2400 Pascal) and hailstone, snow loads (5400 Pascal)

Shinetime sorting standards.
All Shinetime modules sorted and packaged by power reducing mismatch losses of up to 3%.

Certified manufacturing facility.
Manufacturing facility certified by TÜV Rheinland to ISO 9001:2008. ISO14001:2004.

Warranty

5 years warranty on 95% of nominal power output.
12 years warranty on 90% of nominal power output.
25 years warranty on 80% of nominal power output.
5 years material and workmanship warranty.

Packing Configuration

Module Size (mm)	1650*992*50
Packing Size (mm)	**Packing Type**
1690*1010*110	2 Pcs/Ctn, 17 Ctns/Pallet, 204 Pcs/20'GP
	2 Pcs/Ctn, 17 Ctns/Pallet, 442 Pcs/40'GP
1690*1030*860	15 Pcs/Ctn, 390 Pcs/40'GP
1690*1030*1120	20 Pcs/Ctn, 520 Pcs/40'HQ

Certifications and standards:
IEC 61215, IEC 61730, conformity to CE.

Electrical Specifications

Electrical Specifications at STC (1000w/m², AM1.5, cell temperature 25℃)

Type		XTP6-60-220	XTP6-60-225	XTP6-60-230	XTP6-60-235	XTP6-60-240	XTP6-60-245
Max. Power	P_{MAX}(Wp)	220	225	230	235	240	245
Max.Power Voltage	U_{MPP}(V)	29.8	29.9	30.0	30.1	30.2	30.3
Max.Power Current	I_{MPP}(A)	7.38	7.53	7.67	7.81	7.95	8.09
Open-Circuit Voltage	V_{OC}(V)	36.0	36.1	36.2	36.3	36.4	36.5
Short-Circuit Current	I_{SC}(A)	8.11	8.22	8.34	8.46	8.56	8.64
Cell Efficiency	(%)	≥15.54	≥15.89	≥16.24	≥16.60	≥16.95	≥17.30
Module Efficiency	(%)	≥13.44	≥13.75	≥14.05	≥14.36	≥14.66	≥14.97
FF	(%)	75.35	75.82	76.18	76.52	77.03	77.69

Mechanical Properties

Frame	Aluminium anodized, screwed design
Dimensions	1650*992*50 mm (156*156 mm cell)
Weight	19.5 kg
Front Cover	3.2 mm ultra clear, low iron tempered glass, with high light transmittance.
Backside Cover	TPT
Cells per Module	60 pcs
Cell Type	Polycrystalline 156*156mm

Thermal Characteristics

Norminal Operating Cell Temp. (NOCT)	47℃(±2℃)
Temp. Coefficient Voltage (Voc)	-0.35%/℃
Temp. Coefficient Current (Isc)	+0.04%/℃
Temp. Coefficient Power (Pm)	-0.48%/℃

System Integration

Class of Usage (IEC 61730)	A
Fire Rating (IEC 61730)	C
Tolerance Range (%)	+4%
Max. Series Fuse	15 A
Cable (TÜV Checked)	2 * 900 mm, 4mm²
Type of Connector (TÜV Checked)	MC4 Compatible
Junction Box (TÜV Checked)	IP 67, 6 Bypass Diodes
Allowable Hail Load	242 steel ball fallen down from 1m height
Max. Systems Voltage (DC)	1000 V (IEC)

Appendix 7: Outline for a Commissioning Plan

Commissioning Plan Outline

1. General Building Information

Project Name	
Project Address	
Building Type	
Square Footage	
Building Description	
Owner Agency	
Scheduled Completion Date	

2. Overview

2.1 Abbreviations and Definitions

The following are common abbreviations used in this document.

A/E	Architect and design engineers	FPT	Functional performance test
CP	Commissioning provider	GC	General contractor
CC	Controls contractor	MC	Mechanical contractor
CX	Commissioning	PF	Pre-functional checklist
EM	Energy Manager	PM	Project Manager
CX Plan	Commissioning Plan document	Subs	Subcontractors to General
EC	Electrical contractor	TAB	Test and balance contractor
MM	Maintenance Manager	Staff	Maintenance Staff

2.2 Purpose of the Commissioning Plan

The purpose of the commissioning plan is to provide direction for the commissioning process during construction, providing resolution for issues such as scheduling, roles and responsibilities, lines of communication and reporting, approvals, and coordination.

2.3 Commissioning Goals and Objectives

Commissioning is a systematic process of ensuring that the building systems perform according to the design intent and the owner's operational requirements. All equipment and systems should be installed according to manufacturer's recommendations and the best practices and standards of the industry.

Commissioning will include documenting the design intent, followed by activities in the construction, acceptance, and warranty phases of the project. The participation of the contractors in commissioning activities will follow the requirements defined in the specifications. The three main goals of the commissioning process are:

Energy Design Resources Commissioning Plan

1. Facilitate the final acceptance of the project at the earliest possible date.
2. Facilitate the transfer of the project to the owner's maintenance staff.
3. Ensure that the comfort systems meet the requirements of the occupants.

Commissioning is also intended to achieve the following specific objectives:

- Document that equipment is installed and started per manufacturer's recommendations.
- Document that equipment and systems receive complete operational checkout by installing contractors.
- Document system performance with thorough functional performance testing and monitoring.
- Verify the completeness of operations and maintenance materials.
- Ensure that the owner's operating personnel are adequately trained on the operation and maintenance of building equipment.

2.4 Commissioning Scope

The following marked systems will be commissioned in this project. All general references to equipment in this document refer only to equipment that is to be commissioned.

System	Equipment	Check
HVAC System	Chillers	
	Pumps	
	Cooling tower	
	Boilers	
	Piping systems	
	Ductwork	
	Variable frequency drives	
	Air handlers	
	Packaged AC units	
	Packaged HP units	
	Terminal units	
	Unit heaters	
	Heat exchangers	
	Computer room cooling units	
	Fume hoods	
	Lab room pressures	
	Exhaust fans	
	Chemical treatment systems	
	HVAC control system	

Energy Design Resources Commissioning Plan

	Fire and smoke dampers	
Electrical System	Sweep or scheduled lighting controls	
	Daylight dimming controls	
	Lighting occupancy sensors	
	Power quality	
	Security system	
	Emergency power system	
	UPS systems	
	Fire and smoke alarm systems	
	Fire protection systems	
	Communications system	
	Public address/paging systems	
	Low Voltage Distribution Cable	
	Distribution Panel Circuit Breakers	
	Ground Fault Detection	
	Automatic Transfer Switch	
Other	Service water heaters	
	Refrigeration systems	
	Kitchen Equipment	

Energy Design Resources Commissioning Plan

3. Commissioning Team Information

Function	Name/Address	Contact Info
Owner		
Project Manager		
Commissioning Provider		
Architect		
Mechanical Engineer		
Electrical Engineer		
General Contractor		
Mechanical Contractor		
Electrical Contractor		
Controls Contractor		
Maintenance Manager		

Energy Design Resources Commissioning Plan

4. Roles and Responsibilities

General Management Plan

In general, the CP coordinates the commissioning activities and reports to the owner's construction representative. The CP's responsibilities, along with all other contractors' commissioning responsibilities are detailed in the specifications. The Specifications will take precedence over this Commissioning Plan. All members work together to fulfill contracted responsibilities and meet the objectives of the Contract Documents.

4.1 General Descriptions of Roles

General descriptions of the commissioning roles are as follows:

CP: Coordinates the CX process, writes and/or reviews testing plans, directs and documents performance testing.

PM: Facilitates and supports the CX process and gives final approval of the CX work.

MM: Coordinates maintenance staff participation in commissioning activities.

GC: Facilitates the CX process, ensures that Subs perform their responsibilities and integrates CX into the construction process and schedule.

Subs: Demonstrate correct system performance.

Staff: Participate in commissioning tasks and performance testing, review O&M documentation, attend training.

A/E: Perform construction observation, approve O&M manuals and assist in resolving problems.

Mfr.: Equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform contracted startup.

4.2 Specifications and Commissioning

Commissioning language in the specifications details the scope of commissioning for this project. The following table lists the sections of the specifications that include commissioning related language with a brief description.

Table 4-1: Specifications Related to Commissioning

Section	Description

Energy Design Resources Commissioning Plan

4.3 General Management Plan and Protocols

The following protocols will be used on this project.

Issue	Protocol
For requests for information (RFI) or formal documentation requests:	The CP goes first through the PM.
For minor or verbal information and clarifications:	The CP goes direct to the informed party.
For notifying contractors of deficiencies:	The CP documents deficiencies through the PM, but may discuss deficiency issues with contractors prior to notifying the PM.
For scheduling functional tests or training:	The CP provides input and coordination of testing and training. Scheduling is done through the PM.
For scheduling commissioning meetings:	The CP selects the date and schedules through the PM.
For making a request for significant changes:	The CP has no authority to issue change orders.
For making minor changes in specified sequences of operations:	Any required changes in sequences of operations required to correct operational deficiencies must be approved and documented by the PM and A/E team. The CP may recommend to the PM changes in sequences of operation to improve efficiency or control.
Subcontractors disagreeing with requests or interpretations by the CP shall:	Resolve issues at the lowest level possible. First with the CP, then with the GC and PM. Some issues may require input from the A/E team.

Energy Design Resources Commissioning Plan

5. Commissioning Process

This section sequentially details the commissioning process by commissioning task or activity.

5.1 Commissioning Scoping Meeting

The scoping meeting brings together all members of the design, construction, and operations team that will be involved in the commissioning process. Each building system to be commissioned is addressed, including commissioning requirements, and completion and start-up schedules. During the scoping meeting, all parties agree on the scope of work, tasks, schedules, deliverables, and responsibilities for implementation of the Commissioning Plan.

5.2 Final Commissioning Plan

The commissioning agent finalizes the draft Commissioning Plan using the information gathered from the scoping meeting. The initial commissioning schedule is also developed along with a detailed timeline. The timeline is fine-tuned as construction progresses.

5.3 Design Intent Documentation

The design requirements, relative to the building systems selected for commissioning, must be explicitly documented in order to establish a baseline of performance expectations to which the actual installed performance is compared. The commissioning provider, with the assistance of the building owner and design team, prepares a Design Intent Summary that documents the design intent for those building systems selected for commissioning. The Design Intent Summary reflects the underlying assumptions and requirements that become represented in the construction documents.

5.4 Submittals

The general contractor will provide the commissioning agent with a set of equipment and system submittals. This equipment data includes installation and start-up procedures, O&M data, performance data and temperature control drawings. The subcontractors, general contractor or A/E notify the commissioning agent of any new design intent or operating parameter changes, added control strategies and sequences of operation, or other change orders that may affect commissioned systems.

5.5 Site Observation

The commissioning agent makes periodic site visits to witness equipment and system installations. Each site visit will have a specific agenda and will be coordinated with the general contractor site supervisor. The commissioning agent attends selected planning and job-site meetings in order to remain informed on construction progress and to update parties involved in commissioning. The general contractor provides the commissioning agent with information regarding substitutions or change orders that may affect commissioned equipment or the commissioning schedule.

Energy Design Resources Commissioning Plan

5.6 Pre-functional Checklists and Startup Procedures

A Pre-Functional Inspection Checklist are developed and completed for all mechanical equipment being commissioned. The checklist captures equipment nameplate and characteristics data, and confirms the as-built status of the equipment or system. The checklists ensure that the systems are complete and operational and document the installation of components and completion of systems.

The checklists are prepared by the commissioning agent from manufacturer's data, drawings and specifications to include the required installation, checkout, and start up procedures. The installing subcontractors date and initial the checklists as the construction and start-up is completed. The commissioning agent reviews and verifies the completed checklists before scheduling the functional performance testing.

5.7 Development of Functional Test and Verification Procedures

Functional performance testing verifies the intended operation of individual components and system interactions under various conditions and modes of operation. The systems are run through all of the sequences of operation and the response of components is verified. Testing proceeds from components to subsystems to systems, and finally to interlocks and connections between systems.

The commissioning agent prepares functional performance test plans so that the complete sequence of operations is included. The commissioning agent obtains all documentation, including an updated points list, control sequences, and setpoints. If necessary, the commissioning agent may request clarifications from contractors and the design team regarding sequences and operation. Prior to execution, the commissioning agent provides a copy of the primary equipment tests to the installing subcontractor and general contractor who can review the tests for feasibility, safety, warranty and equipment protection.

5.8 Execution of Functional Testing Procedures

The commissioning agent schedules functional tests through the general contractor and subcontractors. Under the supervision of the commissioning agent, the installing subcontractor performs the hardware and/or software manipulations required for the testing. Owner maintenance staff may also be present in order to assist in system observations. The commissioning agent witnesses and records the results of functional performance testing.

Any deficiencies found from functional performance testing will be documented in a Deficiency Report. The report will include all details of the components or systems found to be non-compliant with the parameters of the functional performance test plans and design documents. The deficiency report will become part of the punch list. The report will detail the adjustments or alterations required to correct the system operation, and identify the responsible party. The deficiency report will be continuously updated. The commissioning agent schedules any required retesting through the general contractor. Decisions regarding deficiencies and corrections are made at as low a level as possible, preferably between commissioning agent, sub-contractor and general contractor.

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5.9 Short-Term Diagnostic Monitoring

Short-term diagnostic testing, using data acquisition equipment or building automation system trends to record system operation over a two to three week period, may be used to investigate the dynamic interactions between components in the building system.

The monitoring occurs after occupancy to evaluate the building systems' performance under natural occupancy and ambient load conditions. The objectives of the monitoring are to evaluate scheduling, the interaction between heating and cooling, and the effectiveness of the system in meeting the comfort requirements of the occupants. .

5.10 Operations and Maintenance Manuals

The operation and maintenance manuals prepared by the contractors for the owner's maintenance personnel are reviewed for completeness. The contractors are encouraged to submit O&M manuals at the earliest possible date. Materials may be added, or requested from the contractors, to stress and enhance the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation. A database of preventative maintenance information may also be created from the materials in the O&M manuals.

5.11 Training and Orientation of Owner Personnel and Occupants

Effective maintenance personnel training is critical to the long term performance of the new building. The commissioning agent will assist the owner and general contractor in organizing the training sessions by identifying the appropriate staff for each session and creating an overall training plan.

For each training session, the contractors provide a detailed agenda for each piece of equipment or system for which training is required. The agenda describes the training scope, duration, and methods, along with the name and qualifications of the trainers. The commissioning agent develops a plan for including in the training session contractors / trainers from different disciplines, when appropriate. The trainer documents each training session (duration, general subjects covered, and attendees). The commissioning agent may witness any of the training sessions.

5.12 Warranty Period

Seasonal variation in operations or control strategies may require additional testing during peak cooling and heating seasons to verify system performance. During the warranty period, seasonal testing and other deferred testing is completed as required to fully test all sequences of operation. The commissioning agent coordinates this activity. Tests are executed and deficiencies corrected by the appropriate subcontractors, witnessed by facilities staff and the commissioning agent. Any final adjustments to the O&M manuals and as-builts due to the testing are made.

The commissioning agent will request input from the owner's operations staff and occupants about the performance of the building systems. The commissioning agent also supports the general contractor's troubleshooting process during the warranty period. The general contractor's warranty team will first try and resolve the issues before requesting assistance from the commissioning agent.

5.13 Commissioning Report

A final Commissioning Report will be compiled which summarizes all of the tasks, findings, and documentation of the commissioning process. The report will address the actual performance of the building systems in reference to the design documents. All test reports by various sub-contractors, manufacturers and controlling authorities will be incorporated into the final report.

The commissioning report includes:

- An evaluation of the operating condition of the systems at the time of functional test completion,
- Deficiencies that were discovered and the measures taken to correct them,
- Functional test procedures and results,
- Reports that document all commissioning field activities as they progressed, and
- A description and estimated schedule of required deferred testing.

6. Schedule

6.1 General Issues

The following sequential priorities are followed:

1. Equipment is not "temporarily" started (for heating or cooling), until pre-start checklist items and all manufacturer's pre-start procedures are completed and moisture, dust and other environmental and building integrity issues have been addressed.
2. Functional performance testing does not begin until pre-functional, start-up and TAB is completed for a given system.
3. The controls system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional checklists are completed.

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