Whole Building Design Guide

- The Whole Building Design Guide – A High-Performance Primer

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High-Performance Buildings Defined

High-Performance building means a building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy [and water] conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.

- Energy Independence and Security Act of 2007 §401 (PL 110-140)
Attributes for High Performance

- Sustainable
- Cost Effective
- Accessible
- Productive
- Historic
- Functional
- Safe/Secure
- Aesthetics
Why is this important to you?

How can the Whole Building Design Guide help you achieve High-Performance?
Factors Influencing Current & Future Building Projects

... and these are just some of the Sustainability Factors!!!
What Is Whole Building Design?

To achieve high-performance buildings

- It takes an **Integrated Design Approach** and it requires an
- **Integrated Team Process**
‘Whole Building’ Approach

• Materials, systems, and assemblies reviewed from many different perspectives

• Building components, sub-systems and materials are interdependent, can impact the total performance of the whole, and can perform ‘double duty’

NREL Solar Laboratory
Golden, CO
Integrated Project Team

- Comprehensive Stakeholder involvement throughout the building’s life cycle

- Evaluation for cost, quality-of-life, future flexibility, energy efficiency, overall environmental impact, productivity, creativity, and how the occupants will be enlivened

The George D. Aiken Center at the University of Vermont
Photo Credit: Jim Westphalen
(WBDG Award Winning Case Study)
Applying the Integrated Team Process

Who needs to be at the table at the outset of your project to ensure an integrated team process?

- Architect / Landscape Architect
- Owner, Client, Tenants
- Engineers
- Programmers
- Interior Designer
- Contractor
- Specialists (Security, IT/Telecom, Acoustics)
- Community Members or Other Stakeholders
- Operations and Maintenance Personnel
- Others???? (Real Estate Buyer)

An Integrated Team can find a single design strategy that meets multiple design objectives. This is a tactic that can control project cost!
Building Site Selection

- Solar Access*
- Sea Level Rise
- Stormwater Management
- Undeveloped Land/Wetlands
- Public Transportation
- Occupant Amenities
- Compatible Functions
- Security (ATFP, CPTED)
- Disaster Avoidance

*Building orientation for passive solar heating, daylighting, natural ventilation, views, potential impacts of future development.

Note: Applies to Selecting an Existing Building, as well!
The Building as a System

- the building enclosure (building envelope system);
- the inhabitants (humans and/or animals and/or plants, etc.);
- the building services (electrical/mechanical systems);
- the site, with its landscape and services infrastructure; and
- the external environment (weather and micro-climate).

Harmonization of these elements is the key to achieving high performing buildings.

From Prof. Kesic
Building Science Concepts
WBDG Resource Page
Design Guidance

Design Objectives
- Design Objectives contains information organized by the specific design goal

Building Types
- Building Types contains information organized by the type of building or use

Space Types
- Space Types contains information organized by the type of functional space within buildings

Design Disciplines
- Design Disciplines contains information organized by the professional disciplines' role in the 'whole building' process

Products & Systems
- Products & Systems contains information organized by CSI MasterFormat™ or UniFormat™

Multiple links between various sections of the WBDG and the Internet allow you to easily access all relevant online information related to a topic, including design tools, federal mandates, and government and non-government standards. At the bottom-most level of the site, browse in-depth technical summaries, called Resource Pages, written by industry experts.
Attributes for High Performance

= WBDG Design Objectives

• Accessible
• Aesthetic
• Cost-Effective
• Functional/Operational
• Historic Preservation
• Productive
• Secure/Safe
• **Sustainable**
Optimize Energy Use
by the WBDG Sustainable Committee
Last updated: 09-04-2013

OVERVIEW

On an annual basis, buildings in the United States consume 39% of America’s energy and 86% of its electricity. Furthermore, buildings emit 38% of the carbon dioxide (the primary greenhouse gas associated with climate change), 49% of the sulfur dioxide, 3% of the nitrogen oxides found in the air. Currently, the vast majority of this energy is produced from non-renewable, fossil fuels. With the world’s supply of fossil fuel dwindling, demand for energy (and thus fuel prices) continues to rise, concerns for energy supply security increasing (for general supply and specific needs of facilities), and the vast majority of greenhouse gases in the world’s climate rising, it is essential to find ways to reduce waste, increase efficiency, and utilize renewable fuel resources in facilities of all types.

In the facility design and development process, building projects must have a comprehensive, integrated perspective that seeks to:

- Reduce heating, cooling, and lighting loads through climate-responsive design and conservation practices;
- Employ renewable energy sources such as daylighting, passive solar heating, photovoltaics, and geothermal, and groundwater cooling;
- Employ efficient HVAC and lighting systems that consider part-load conditions and utility interface requirements;
- Optimize building performance by employing energy modeling programs and optimize system control strategies by using occupancy sensors, CO₂ sensors and other air quality alarms; monitor project performance through a policy of commissioning, metering, annual reporting, and periodic re-commissioning; and
- Integrate water saving technologies to reduce the energy burden of providing potable water.

Apply this process to the reuse, renovation or repair of existing buildings as well.
RECOMMENDATIONS

Reduce Heating, Cooling, and Lighting Loads through Climate-Responsive Design and Conservation Practices
- Use passive solar design; orient, size, and specify windows; and locate landscape elements with solar geometry and building load requirements in mind.
- Use high-performance building envelopes; select walls, roofs, and other assemblies based on long-term insulation and durability requirements.

Employ Renewable or High-Efficiency Energy Sources
- Renewable energy sources include solar water heating, photovoltaic (PV), wind, biomass, and geothermal. Use of renewable energy can increase energy security and reduce dependence on imported fuels, while reducing or eliminating greenhouse gas emissions associated with energy use. Consider solar thermal for domestic hot water and heating purposes.
- Evaluate the use of building scale to take advantage of on-site renewable energy technologies such as daylighting, solar water heating, and geothermal heat pumps.
- Consider the use of larger-scale, on-site renewable energy technologies such as photovoltaics, solar thermal, and wind turbines.
- Evaluate purchasing electricity generated from renewable sources or low polluting sources such as natural gas.

Specify Efficient HVAC and Lighting Systems
- Use energy efficient HVAC equipment and systems that meet or exceed 10 CFR 434. For Department of Defense facilities, refer to the standards within UFC 3-400-01, Design for Energy Conservation.
- Use lighting systems that consume less than 1 watt/square foot for ambient lighting.
- Use Energy Star® approved and/or FEMP-designated energy efficient products or products that meet or exceed Department of Energy standards.
- Evaluate energy recovery systems that pre-heat or pre-cool incoming ventilation air in commercial and institutional buildings.
- Investigate the use of integrated generation and delivery systems, such as co-generation, fuel cells, and off-peak thermal storage. See also WBDG Distributed Energy Resources (DER) and Microturbines.

Optimize Building Performance and System Control Strategies
- Employ energy modeling programs early in the design process.
- Use sensors to control loads based on occupancy, schedule and/or the availability of natural resources such as daylight or natural ventilation.
- Evaluate the use of modular components such as boilers or chillers to optimize part-load efficiency and maintenance requirements.
- Evaluate the use of Smart Controls that merge building automation systems with information technology (IT) infrastructures.
- Employ an interactive energy management tool that allows you to track and assess energy and water consumption like the Energy Star® Portfolio Manager.

Monitor Project Performance
- Use a comprehensive, building commissioning plan throughout the life of the project.
- Use metering to confirm building energy and environmental performance through the life of the project.
- See also WBDG Facility Performance Evaluation.
Sustainability and Energy Security

Energy independence and security are important components of national security and energy strategies. Today, power is mostly generated by massive centralized plants, and electricity moves along transmission lines. "Getting off of foreign oil" means minimizing energy consumption through energy conservation and efficiency, and generating energy from local, renewable sources, such as wind, solar, geothermal, etc. (see WBDG Distributed Energy Resources, Fuel Cell Technology, Microturbines, Building Integrated Photovoltaics (BIPV), Daylighting, Passive Solar Heating) Additionally, using distributed energy systems adds to building resiliency as the threats of natural disaster damage become more frequent.

EMERGING ISSUES

Net Zero Energy Buildings Executive Order 13514 requires all new Federal buildings that are entering the planning process in 2020 be 'designed to achieve zero-net-energy by 2030.' There are also commercial building and residential programs promoting net-zero energy. Examples of commercial, residential and government net-zero energy buildings exist and can provide guidance for the development of future net-zero energy buildings.

Passive survivability, which is described as the ability of a facility to provide shelter and basic occupant needs during and after disaster events without electric power is becoming a design strategy to consider, particularly in areas of the country where storms and floods have been reoccurring annually or more often. Incorporate facility survivability concepts in the design of critical facilities, including on-site renewable energy sources that will be available to power the building soon after a major storm passes. Checklist for Passive Survivability.

Green Walls or Vertical Gardens, sometimes referred to as 'vegitecture' are beginning to appear as a design element in urban buildings. Be sure they do not conflict with site security requirements including Crime Prevention Through Environmental Design (CPTED).
Minimize Energy Consumption

- Energy Design Resources
- Energy Star, EPA
- Energy Star® for New Building Design
- Federal Energy Management Program (FEMP), DOE
- WBDG case studies: Center for Neighborhood Technology: EPA New England Regional Laboratory; NAVFAC Building 23

Employ Renewable or High Efficiency Energy Sources

- National Renewable Energy Laboratory (NREL)
- Photovoltaics Program, Sandia National Laboratory
- Renewable Energy Policy Project (REPP) and CREST (Center for Renewable Energy and Sustainable Technology)

Specify Efficient HVAC and Lighting Systems

- 10 CFR 434 Subpart A
- ASHRAE 90.1
- FEMP Buying Energy Efficient Products
- Lighting Research Center

Optimize Building Performance and System Control Strategies

- U.S. Department of Energy (DOE), Buildings R&D Breakthrough: Technologies and Products Supported by the Building Technologies Program (PDF 15.6 MB)
- U.S. Department of Energy (DOE), International Performance Measurement and Verification Protocol (IPMVP) volume 1 (PDF 2.5 MB)
- Building Energy Information Systems: State of the Technology and User Case Studies, (PDF 4.98 MB), Lawrence Berkeley National Laboratory, November 2009

Others

- FedCenter.gov—FedCenter, the Federal Facilities Environmental Stewardship and Compliance Assistance Center, is a collaborative effort between the Office of the Federal Environmental Executive (OEEE), the U.S. Army Corps of Engineers Construction Engineering Research Laboratory, and the U.S. EPA Federal Facilities Enforcement Office. FedCenter replaces the previous FedSite as a one-stop source of environmental stewardship and compliance assistance information focused solely on the needs of federal government facilities.
- Executive Order 13423 Technical Guidance
- RenewableEnergyWorld.com

Training Courses

- WBC005 Daylighting Principles and Strategies for Sustainable Design
- WBC006 Sustainable Roofing Design Considerations and Applications
- WBC007 Window and Glazing Design Strategies for Sustainable Design
- WBC008 Building Commissioning Principles and Strategies
Energy & Sustainability Resource Pages

- Air Barrier Systems in Buildings
- Building Enclosure Design Principles and Strategies
- Cool Metal Roofing
- Daylighting
- Electric Lighting Controls
- Energy Efficient Lighting
- Evaluating and Selecting Green Products
- Extensive Vegetative Roofs
- High-Performance EIFS
- High-Performance HVAC
- HVAC System Design for Humid Climates
- Indoor Air Quality and Mold Prevention of the Building Envelope
- Measuring Performance of Sustainable Buildings
- Natural Ventilation
- Passive Solar Heating
- Sun Control and Shading Devices
- Sustainable O&M Practices
- Water Conservation
- Windows and Glazing
Leading-Edge Energy/Sustainable Content

- Green Building Standards & Certification Systems
- Living, Regenerative & Adaptive Buildings
- Greenhouse Gas Emissions in Federal Buildings
- Biomimicry: Designing to Model Nature
- Alternative Energy
- Net Zero Energy Buildings
- Distributed Energy Resources
- Smart Controls
- Combined Heat & Power (CHP)
  - Microgrids*
  - Energy Storage*
  - Green Plumbing*
  * Coming soon

EcoSense in British Columbia is one of the first 3 Living Buildings certified in the world (Photo Credit: ILBI.org.)
Renewable Energy Topics


The WBDG resources pages accompanying the Guide are:

- Biogas
- Biomass for Heat
- Fuel Cells & Renewable Hydrogen
- Geothermal Electric Technology
- Geothermal Heat Pumps
- Ocean Energy
- Passive Solar Heating
- Solar Ventilation

Recently added:

- Fuel Cell Flexibility & Sustainability
- Resiliency of Stationary Fuel Cells & the Natural Gas Grid
Renewable Energy Resource Pages

- **Description:** How does it work; types & cost of technology
- **Application:** Economics; assessing resource availability
- **Design & Procurement considerations**
- **Operations & Maintenance**
- **Special considerations**

The Judith Gap Wind Energy Center in Montana is comprised of 90 GE 1.5-MW turbines, for a total capacity of 135 MW.
Net Zero Energy Buildings

The National Renewable Energy Laboratory (NREL) Research and Support Facility (RSF) Golden, CO is currently the largest NZEB in the U.S. The 220,000 sq. ft. project achieved the Net Zero site energy goal through a performance-based design/build process. Numerous energy efficiency strategies were implemented including incorporating advanced heat recovery technologies that were developed and designed by researchers at the Lab and installing 1.6 megawatts of photovoltaic power on the campus through a Power Purchase Agreement. Additionally, daylighting, natural ventilation, and a next-generation, energy efficient data center are among other energy features of the building.

http://www.wbdg.org/resources/netzeroenergybuildings.php
Living, Regenerative, and Adaptive Buildings

This Arboretum and Research Visitor’s Center designed for adaptability, optimizes material use over the life cycle of the building by integrating flexibility and disassembly into the design.

(Photo Credit: Lifecycle Building Challenge Awards)

These Eco-Machines are wastewater filtration systems that utilize multiple filtration processes from anaerobic to mechanical.

http://www.wbdg.org/resources/livingbuildings.php
Biomimicry: Designing to Model Nature

Inspired by biological systems that heal themselves when damaged, a self-healing polymer, created at the Beckman Institute, University of Illinois is being applied to the development of a structural polymeric building material, such as cladding, with the ability to self-heal cracks.

http://www.wbdg.org/resources/biomimicry.php
Accessible
by the WBDG Accessible Committee
Last updated: 10-22-2014

OVERVIEW

“We hold these truths to be self-evident: that all men are created equal…”
- Declaration of Independence, July 4, 1776

In daily life, as we maneuver through society, nothing is more important yet taken for granted more often than access. For millions of people with disabilities, the access that most of us take for granted is difficult, impossible, or achievable only with the intervention of a third party. We live in what is considered an independent society, yet independent access to programs, facilities, and employment is not easily achievable by many. Physical access is historically the arbiter of success and the source of opportunity in education, employment, and social freedom. Thus, accessibility is a civil rights issue for many people with disabilities and for our society. See the History of Accessible Facility Design to learn more.

Definition and Goals of Accessible Design

ADA and ABA Accessibility Guidelines

The U.S. Access Board issues accessibility guidelines under the Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA). The Board's guidelines are the mandatory baseline for accessibility standards issued by other Federal agencies authorized to establish accessibility standards under the ADA or the ABA. Until the Board's guidelines are adopted by one or more of these standard-setting agencies, they are not enforceable.

In 2004, the Access Board updated its ADA and ABA Accessibility Guidelines and published them in a single document containing three parts. Part 1 contains application and scoping for ADA covered facilities; Part 2 contains application and scoping for ABA covered facilities; and Part 3 contains technical requirements common to both the ADA and ABA.
Aesthetics
by the WBDG Aesthetics Subcommittee
Last updated: 10-21-2014

OVERVIEW

In The Ten Books of Architecture the ancient Roman architect Vitruvius stated that a building should meet obligations of commodity, firmness, and delight. Commodity addresses how a building serves its function and can be made more useful. Firmness means a building's ability to stand up to natural forces over time. Delight refers to aesthetics.

Aesthetics is a branch of philosophy devoted to beauty. It dissects visual elements like proportion and line, as well as other formal qualities—auditory, tactile, olfactory, thermal, and even kinesthetic—that achieve beauty. It also studies changing concepts, such as political environment or social status, that affect people's perception of what is beautiful. In the case of architecture, these underlying concepts may include branding, imageability, ideas about community, and the importance of technology. Not surprisingly, then, standards of beauty vary according to time and culture.

So do the ways that beauty is manifest—which is known as style. The early 21st century is a remarkable period in architecture because it features pre-modern historical styles in great variety (Classicism and its many iterations, including Romanesque, Gothic, Victorian, Craftsman, Art Deco, Postmodern) as well as Modernist forms. Meanwhile, forms of contemporary architecture are continually evolving; they cannot be pinned down as a style until a critical mass of buildings has consistently satisfied one set of compositional and conceptual criteria.
**Cost-Effective**

by the WBDG Cost-Effective Committee

_Last updated: 11-15-2012_

**OVERVIEW**

"We no longer build buildings like we used to, nor do we pay for them in the same way. Buildings today are...life support systems, communication terminals, data manufacturing centers, and much more. They are incredibly expensive tools that must be constantly adjusted to function efficiently. The economics of building has become as complex as its design." (Wilson, in foreword to Ruegg & Marshall, 1990)

Every owner wants a cost-effective building. But what does this mean? In many respects the interpretation is influenced by an individual's interests and objectives, and how they define "cost-effective".

- Is it the lowest first-cost structure that meets the program?
- Is it the design with the lowest _operating and maintenance_ costs?
- Is it the building with the longest _life span_?
- Is it the facility in which users are most _productive_?
- Is it the building that offers the greatest return on investment?

While an economically efficient project is likely to have one or more of these attributes, it is impossible to summarize cost-effectiveness by a single parameter. Determining true cost-effectiveness requires a life-cycle perspective where all costs and benefits of a given project are evaluated and compared over its economic life.

In economic terms, a building design is deemed to be cost-effective if it results in benefits equal to those of alternative designs and has a lower whole life cost, or total cost of ownership. For example, the HVAC system alternative that satisfies the heating and cooling requirements of a building at the minimum whole life cost, is the cost-effective HVAC system of choice. Components of the whole life cost include the initial design and construction cost, on-going operations and maintenance, parts replacement, disposal cost or salvage value, and of course the useful life of the system or building.

The federal government has numerous mandates that define program goals with the expectation that they be achieved cost-effectively.

The challenge is often how to determine the true costs and the true benefits of alternative decisions. For example, what is the economic value in electric lighting savings and productivity increases of providing _daylight_ to workplace environments? Or, what is the value of saving historic structures? Alternately, what is the cost of a _building integrated photovoltaic system (BIPV)_ given that it may replace a conventional roof?
Functional / Operational

by the WBDG Functional / Operational Committee
Last updated: 10-21-2014

OVERVIEW

A clear understanding of the functional and physical requirements of a project is essential to ensuring its success. A client's/owner's intent to develop a project is derived from a need, a purpose or mission, and a desired result. When the design of a facility satisfies the emotional, cognitive, and cultural needs of the people who use it and the technical requisites of the programs it houses, the project is functionally successful. Program and functionality are also characterized by building type. A building that functions as it is intended is the underpinning of a quality "whole" building. The qualities of such a building may not even be noticed or recognized, but a poorly functioning building can be costly to correct, if the opportunity to correct ever becomes available. When designs fall short of this goal, the cost can be modest to extreme, but the failures are generally noted more significantly than the expected successes.

This branch of the WBDG is designed primarily to help those not familiar with architectural and engineering design understand the basic process, technique, and language by which functional decisions are made.

Left: Exterior lateral bracing created open interior spaces at the John Hancock Building—Chicago, IL
Courtesy of Skidmore, Owings and Merrill LLP
Right: CaPERS Headquarters Complex daylight interior atrium space in the building's core
Historic Preservation
by the WBDG Historic Preservation Subcommittee
Last updated: 04-16-2015

OVERVIEW
Preserving historic buildings is vital to understanding our nation’s heritage. In addition, it is an environmentally responsible practice. By reusing existing buildings, historic preservation is essentially a recycling program of ‘historic’ proportions. Existing buildings can often be energy efficient through their use of good ventilation, durable materials, and spatial relationships. An immediate advantage of older buildings is that a building already exists; therefore, energy is not necessary to demolish a building or create new building materials and the infrastructure may already be in place. Minor modifications can be made to adapt existing buildings to compatible new uses. Systems can be upgraded to meet modern building requirements and codes. This not only makes good economic sense, but preserves our legacy and is an inherently sustainable practice and an intrinsic component of whole building design. (See also Sustainable and Sustainable Historic Preservation.)

Realizing the need to protect America’s cultural resources, Congress established the National Historic Preservation Act (NHPA) in 1966, which mandates the active use of historic buildings for public benefit and to preserve our national heritage. Cultural resources, as identified in the National Register for Historic Places, include buildings, archeological sites, structures, objects, and historic districts. The surrounding landscape is often an integral part of a historic property. Not only can significant archaeological remains be destroyed during the course of construction, but the landscape, designed or natural, may be irreparably damaged, and caution is advised whenever major physical intervention is required in an extant building or landscape. The Archaeological Resources Protection Act established the public mandate to protect these resources.

Some practical and/or intangible benefits of historic preservation include:
- Retention of history and authenticity
  - Commemorates the past
    - Aesthetics: texture, craftsmanship, style
    - Pedestrian/visitor appeal
    - Contextual and human scale
- Increased commercial value (Economic Benefits)
PRODUCTIVE

by the WBDG Productive Committee
Last updated: 11-15-2012

OVERVIEW

Wise use of space means creating the right context for concentration, learning, communication, and collaboration—the building blocks of productivity.

Organizations, business practices, educational settings and learning methodologies, and the workforce have changed dramatically in the past two decades. Technological advances, demographic shifts, and continual demands for innovation have created pressures for environments to catch up with the changing nature of organizations, work and workplace.

Organizational effectiveness today means using space more wisely. This does not just mean cutting costs. It means designing for flexibility to enable space to change as work groups, activities, and projects evolve. Information in these Productive pages must be considered together with other design objectives and within a total project context in order to achieve quality, high-performance buildings. Also, workplace productivity strategies support sustainable design principles and should be taken on balance for the longevity of all the issues considered.

It is often hard to quantify the impacts of specific components of the indoor environment on productivity, because individual and group effectiveness is tied to many different factors— including compensation levels, management practices, and environmental comfort. It is difficult, if not impossible, to isolate individual physical factors, such as the presence or absence of team rooms, daylighting, natural meeting places, or control over the environment. This problem is exacerbated by the case of employees whose "output" is knowledge or insight that cannot be easily quantified.

The Office of Government-wide Policy at the GSA headquarters building in Washington, DC was designed to maximize flexibility, allowing new occupants to change the space to fit their group and individual needs.
Secure / Safe
by the WBDG Secure / Safe Committee
Last updated: 08-18-2014

OVERVIEW

The design and construction of secure and safe buildings (minimal danger or risk of harm) continues to be the primary goal for owners, architects, engineers, project managers, and other stakeholders. In addition to those listed, other stakeholders include: construction managers, developers, facilities managers, code officials, fire marshals, building inspectors, city/county/state officials, emergency managers, law enforcement agencies, lenders, insurers, and product manufacturers. Realizing this goal is often a challenge due to funding limitations, resistance from the occupants due to impacts on operations, productivity and accessibility, and the impacts on the surrounding environment and building architecture due to perimeter security, hardening, and standoff requirements. Understanding the impact site security has on the overall security of the building is important as well. A balance between the security and safety goals and the other design objectives and needs of the facility can be attained. The establishment of an integrated design process where all of the design team members understand each other’s goals can aid in overcoming these challenges and will lead to the development of a solution which addresses all of the requirements. Understanding the interrelationship with the other WBDG design objectives (i.e., Sustainable, Aesthetics, Cost-Effective, Historic Preservation, Accessible, Functional/Operational, and Productive), early in the design process, is an essential step in overcoming the obstacles commonly encountered in the achievement of a secure and safe building.

Designing buildings for security and safety requires a proactive approach that anticipates—and then protects—the building occupants, resources, structure, and continuity of operations from multiple hazards. The first step in this process is to understand the various risks they pose. There are a number of defined assessment types to consider that will lead the project team in making security and safety design decisions. This effort identifies the resources or “assets” to be protected, highlights the possible perils or “threats,” and establishes a likely consequence of occurrence or “risk.” This assessment is weighed against the vulnerabilities specific to the site or facility. Based on these assessments and

Exterior of National Museum of the American Indian—Washington, DC
Security/Safety & Related Pages in WBDG

- Air Decontamination
- Balancing Security/Safety & Sustainability Objectives
- Blast Safety of the Building Envelope
- The Bollard: Crash- & Attack-Resistant Models
- The Bollard: Non-Crash & Non-Attack-Resistant Models
- CBR Safety of the Building Envelope
- Cost Impact of the ISC Security Criteria
- Cybersecurity
- Designing Buildings to Resist Explosive Threats
- Effective Site Security Design
- Facility Performance Evaluation (FPE)
- Flood Resistance of the Building Envelope
- Glazing Hazard Mitigation
- Landscape Architecture & the Site Security Design Process
- Life-Cycle Cost Analysis (LCCA)
- Retrofitting Buildings to Resist Explosive Threats
- Security and Safety in Laboratories
- Seismic Design Principles
- Seismic Safety of the Building Envelope
- The Site Security Design Process
- Threat/Vulnerability Assessments and Risk Analysis
- UFC/ISC Security Design Criteria Overview & Comparison
- Wind Safety of the Building Envelope
- Windows and Glazing
Security Design Strategies

- Security Issues must be addressed in concert with other design objectives and integrated into the overall building design early in the process to ensure a high-performance building with effective security.

Multi-Hazard Design
Looks at impact of all hazards on project:
Natural, Criminal, Terrorist, Accidental
Critical to Balance Security & Sustainability Objectives

• These objectives appear in every project to varying degrees
• Conflicting requirements lead to compromises and tradeoffs
• Synergies can be found when considered early in the project development process

SITE BLDG ENVELOPE STRUCTURE
LIGHTING ELECTRIC POWER HVAC/IEQ
Site Tradeoffs

A facility's risk can be increased and security can be compromised by:

• siting it in an urban area to protect greenfields and preserve habitat and natural resources;
• locating carpool/vanpool parking and bike racks nearby to promote alternative transportation;
• constructing under-building parking to minimize habitat disturbance; and
• installing covered walkways and landscaping to reduce heat islands and control erosion.
Site Tradeoffs

On the other hand, security measures such as

- building setbacks, or standoff distances, to create protective building perimeters and to restrict access;

- installing barriers (e.g., bollards, reinforced planters, & site furnishings) to withstand assaults by moving vehicles;

- locating parking areas in remote areas and/or eliminating under-building parking areas to minimize blast effects from potential vehicle bombs

usually result in increased development of open space, habitat disturbance, and possibly erosion.
Training Courses – WBDG Continuing Education Program

Over 70 free courses
# Case Studies and High Performance Building Database

Below you will find case studies that demonstrate the 'whole building' process in facility design, construction and maintenance. Click on any arrow in a column to arrange the list in ascending or descending order.

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<th>Case Study</th>
<th>Category</th>
<th>Building Type</th>
<th>Size</th>
<th>Beyond Green Award Winner</th>
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<td>The Built Center</td>
<td>Project: New Construction</td>
<td>Office Building</td>
<td>52,000 ft²</td>
<td>2014</td>
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<td>Karuna House</td>
<td>Project: New Construction</td>
<td>Single Family</td>
<td>3,261 ft²</td>
<td>2014</td>
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<td>Smart Supermarkets Program</td>
<td>Innovation: Design, Construction or Operations Processes</td>
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<td>Timber Tower</td>
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<td>Chemeketa Community College Health Sciences Complex</td>
<td>Project: New Construction</td>
<td>Academic</td>
<td>70,000 ft²</td>
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<td>DPR Construction Phoenix Regional Office</td>
<td>Project: Existing Building Renovation or Retrofit</td>
<td>Office Building</td>
<td>16,533 ft²</td>
<td>2013</td>
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Building Envelope Design Guide

The National Institute of Building Sciences (NIBS) under guidance from the Federal Envelope Advisory Committee has developed this comprehensive guide for exterior envelope design and construction for institutional/office buildings. The Envelope Design Guide (EDG) is continually being improved and updated through the Building Enclosure Councils (BECs). Any edits, revisions, updates or interest in adding new information should be directed to the BEDG Review Committee through the 'Comment' link on this page.

INTRODUCTION

BELOW GRADE SYSTEMS

- Foundation Walls
- Floor Slabs
- Plazas, Tunnels, Vaults

WALL SYSTEMS

- Cast-In-Place Concrete
- Exterior Insulation and Finish System (EIFS)
- Masonry
- Panelized Metal
- Precast Concrete
- Thin Stone

FENESTRATION SYSTEMS

- Glazing
- Windows
- Curtain Walls
- Sloped Glazing
Building Envelope Design Guide - Cast-in-Place Concrete Wall Systems
by John F. Duntzmann, PE
Wiss, Janney, Elstner Associates, Inc.
Last updated: 05-01-2009

INTRODUCTION

The Executive House in Chicago is generally known as the first reinforced concrete skyscraper. At the time of its completion in 1959, it was the tallest reinforced concrete building in the United States at 39 stories, or 371 feet. In 1962, the twin towers of Marina City in Chicago set a new record at 538 ft above grade. These distinctive circular, reinforced concrete towers also served as an early example of a cast-in-place concrete wall system. Subsequently, Chicago's Lake Point Tower built in 1968 and Houston's One Shell Plaza built in 1970 set new records at 845 ft and 714 ft, respectively. While both of the latter buildings are clad in materials other than concrete, their innovative structural systems are reflected in their facades and established the precedent for many of the cast-in-place concrete wall systems seen throughout the United States.

Performance Issues
Thermal Performance
Moisture Protection
Fire Safety
Acoustics
Material/Finish Durability
Maintainability
Federal High Performance and Sustainable Buildings

The Federal Government is the nation’s single largest landlord and energy consumer, operating more than 500,000 facilities comprising more than 3 billion square feet. Historically, approximately $30 billion is spent annually on acquiring or substantially renovating Federal facilities, and about $7 billion is spent on energy for Federal facilities. Almost $200 billion is spent on personnel compensation and benefits for civilian employees. This footprint represents an enormous opportunity to transfer sustainable technologies and practices on a large scale, thereby helping to transform the marketplace and create a more healthy work environment.

This section provides the key information needed by Federal personnel to meet high performance and sustainable building (HPSB) requirements including:

- **Policy Background**: Several Executive Orders and legislative mandates direct Federal Agencies to achieve specific HPSB goals. This section provides an overview of these requirements.

- **New Construction & Major Renovation**: Executive Orders 13514 and 13423 require all Federal agencies to comply with the Guiding Principles for New Construction and Major Renovation. This section includes technical guidance needed to meet each of these Guiding Principles.

- **Existing Buildings**: Executive Order 13514 requires at least 15% of each agency’s existing facilities and building leases (above 5,000 gross square feet) to meet the Guiding Principles by 2015. To meet this goal, most agencies must upgrade their existing building stock, which means compliance with a separate set of Guiding Principles for Sustainable Existing Buildings that are detailed in this section.

- **Supporting Technical Guidance**: This section includes additional supporting technical guidance to help agencies meet HPSB requirements.

Will be updated to cite EO 13693 requirements
Retrofitting Existing Buildings to Improve Sustainability and Energy Performance

by Richard Paradis, P.E., BSCP, Bd. Cert. Noise Control Engineer
National Institute of Building Sciences
Last updated: 09-07-2012

INTRODUCTION

Retrofitting an existing building can oftentimes be more cost-effective than building a new facility. Since buildings consume a significant amount of energy (40 percent of the nation’s total U.S. energy consumption), particularly for heating and cooling (32 percent), and because existing buildings comprise the largest segment of the built environment, it is important to initiate energy conservation retrofits to reduce energy consumption and the cost of heating, cooling, and lighting buildings. But conserving energy is not the only reason for retrofitting existing buildings. The goal should be to create a high-performance building by applying the integrated, whole-building design process to the project during the planning or charrette phase that ensures all key design objectives are met. For example, the integrated project team may discover a single design strategy that will meet multiple design objectives. Doing so will mean that the building will be less costly to operate, will increase in value, last longer, and contribute to a better, healthier, more comfortable environment for people in which to live and work. Improving indoor environmental quality, decreasing moisture penetration, and reducing mold all will result in improved occupant health and productivity. Further, when deciding on a retrofit, consider upgrading for accessibility, safety and security at the same time. The unique aspects for retrofit of historic buildings must be given special consideration. Designing major renovations and retrofits for existing buildings to include sustainability initiatives will reduce operation costs and environmental impacts, and can increase building adaptability, durability, and resiliency.

RECOMMENDATIONS

Before making what may amount to a major investment in the retrofit of existing buildings for energy and sustainability improvements, it is important to determine if the investment is worthwhile in perspective with other building conditions. Is the building structurally sound? Are seismoc upgrades needed to meet current standards and local building code requirements? Do hazardous material...
Cybersecurity
By Michael Chipley PhD, PMP, LEED AP, The PM Group LLC
Last updated: 03-26-2013

INTRODUCTION

Industrial Control Systems (ICS) are physical equipment-oriented technologies and systems that deal with the actual running of plants and equipment, include devices that ensure physical system integrity and meet technical constraints, and are event-driven and frequently real-time software applications or devices with embedded software. These types of specialized systems are pervasive throughout the infrastructure and are required to meet numerous and often conflicting safety, performance, security reliability, and operational requirements. ICSs range from building environmental controls (HVAC, lighting), to systems such as the electrical power grid. With the increasing interconnectivity of ICS to the internet, the ICS can be an entry point into the organization’s other IT systems.

Within the controls systems industry, ICS systems are often referred to as Operational Technology (OT) systems. Historically, the majority of OT systems were proprietary, analog, vendor supported, and not internet protocol (IP) enabled. Systems key components, such as Remote Terminal Units (RTUs), Programmable Logic Controllers (PLCs), Physical Access Control Systems (PACS), Intrusion Detection Systems (IDSs), closed circuit television (CCTV), fire alarm systems, and utility meters have become digital and IP enabled. OT systems use Human Machine Interfaces (HMIs) to monitor the processes, versus Graphical User Interfaces for IT systems. Most current ICS systems and subsystems are now a combination of Operational Technologies (OT) and Information Technologies (IT).

The Stuxnet, Duqu, Flame and Shamoon malware were specifically designed to target ICS and cause physical damage to the processes or equipment. Stuxnet “spooled” the integrity of the uranium centrifuges and caused the centrifuges to overspin and self-destruct, while the operators console showed the system was operating within normal parameters. The Duqu malware looks for information that could be useful in attacking industrial control systems. Its purpose is not to be
Resilience

• **Resilience** relates to the design, construction, and operation of buildings and infrastructures that are resilient to natural and man-caused disasters. Buildings designed for resilience can absorb and rapidly recover from a disruptive event.

• Essentially, it is the capacity of a building to continue to function and operate under extreme conditions, such as (but not limited to) extreme temperatures, sea level rise, natural & man-caused disasters, etc.

• Continuity of operations is a major focus of resilience.
Integrated Resilient Design Program

About the Program

The Integrated Resilient Design Program fosters innovative approaches to the design, construction and operation of buildings and infrastructures that are resilient to natural and man-made disasters. Adopting an integrated approach incorporates resilience as one of the primary goals during building design. In addition to protecting the lives of building occupants, buildings that are designed for resilience can absorb and rapidly recover from a disruptive event. Continuity of operations is a major focus. To achieve such integration requires active collaboration among all of the building team members involved in the design process and incorporates the use of new materials and technologies. The end result produces buildings and infrastructures that are resilient, cost effective, resource efficient, durable and high-performing.

Current Integrated Resilient Design Program projects are sponsored by the Department of Homeland Security’s Science and Technology Directorate, whose High Performance Integrated Design Resilience (HPIDR) program develops tools and resources so users—owners, designers and others—can integrate resilience to reduce the impact of a disruptive event and the duration of its effects. More information about the DHS HPIDR program is available at www.dhs.gov/bips.

Current initiatives of the program involving the Institute include:

- High Performance-Based Design for Buildings
- Advanced Materials Council and Data Base
- Security Information and Technology Exchange (SITE)
- Security, Energy and Environmental Program (SEE)
- Integrated Rapid Visual Screening for Buildings, Mass Transit Stations, Tunnels and Airports
- High Performance Concrete Council
- Journal of Hazard Mitigation and Risk Assessment (JMAT)
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Other NIBS Resources

The Owners Performance Requirements (OPR) Tool helps building owners identify priorities and prepare a performance plan for a project by selecting targets for each of the attributes identified as comprising high performance by the Energy Independence and Security Act of 2007 (EISA). The OPR Tool, focused in this version on the building envelope for office buildings, establishes a performance based plan for the owner to provide to the design team at the beginning of project programming. Learn more....

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Resources

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About the OPR Tool
About the NIBS Integrated Resilient Design Program

www.oprtool.org
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- Are enduring assets in their communities
- Support and enhance human performance
- Reduce operating costs
- Are safe, secure, accessible
- Protect the environment
- Are the result of using a whole building approach
Getting to High-Performance

- A high-performance, energy-efficient building is best achieved using the integrated design approach.
- Conduct charrettes & project team meetings from concept through planning, design & construction (include O&M folks).
- So, now you know that the best resource available to plan, design, construct, operate & maintain New Buildings and major Building Renovation Projects is the **Whole Building Design Guide**.
Whole Building Design Guide

Thank you for your time!

QUESTIONS??

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