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SUSTAINABLE DESIGN OF FACILITIES

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This mandatory functional series document is available to all online at <http://engstandards.lanl.gov>.
It derives from P342, Engineering Standards, which is issued under the authority of the Division Leader of Engineering Services as part of the Conduct of Engineering program implementation at the Laboratory.

Revision Record

Rev	Date	Description	POC	OIC
0	2/9/04	Initial issue as ESM Ch 1 Section Z10 App A, expanding SD material from Arch Chapter.	Tobin H. Oruch, <i>FWO-DO</i>	Gurinder Grewal, <i>FWO-DO</i>
1	6/9/04	Organizational and wording changes for clarity.	Tobin H. Oruch, <i>FWO-DO</i>	Gurinder Grewal, <i>FWO-DO</i>
2	5/18/05	Z10 App A became Ch 14. Added waste min plan, IECC vice 90.1 option for GPPs, LEED for line items, other minor changes.	Tobin H. Oruch, <i>ENG-CE</i>	Gurinder Grewal, <i>ENG-CE</i>
3	10/27/06	Admin changes only. Org and contract reference updates. Doc number changes based on IMP 341. Other admin changes.	Tobin Oruch, <i>CENG</i>	Kirk Christensen, <i>CENG</i>
4	6/11/07	Added 30% better than ASHRAE 90.1-2004. LANL to pay LEED fees.	Tobin Oruch, <i>CENG</i>	Kirk Christensen, <i>CENG</i>
5	6/16/08	Revised to address changes in final 10CFR433, including additions, HVAC upgrades, plug load calcs, projects underway. Incorporated 430.2B requirements including LEED Gold and ENERGY STAR. Deleted PM 411 and other old reporting requirements.	Tobin Oruch, <i>CENG</i>	Kirk Christensen, <i>CENG</i>
6	8/25/10	Added IECC as minimum requirement for new buildings, additions, and alterations. Deleted 10CFR433/434 for process buildings. Noted \$5M LEED is TEC and deleted restriction to LEED-NC; delivery team to pay fees. Eliminated report for sub-LEED buildings.	Tobin Oruch, <i>CENG</i>	Larry Goen, <i>CENG</i>
7	4/5/11	Deleted 30% > ASHRAE for renovations; clarified HPSB requirement; for LEED, added off-ramps and clarified.	Tobin Oruch, <i>CENG</i>	Larry Goen, <i>CENG</i>
8	8/28/13	Updated LEED driver, criteria; ASHRAE 2007 or 2010 vice 2004. EPP requirements and Att 1; other changes.	Tobin Oruch, <i>ES-DO</i>	Larry Goen, <i>ES-DO</i>
9	11/26/18	New summary table, 90.1 and/or IECC, invoked 10CFR433 directly, newer HPSB GPs, new LEED threshold, other changes.	Tobin Oruch, <i>ES-FE</i>	Larry Goen, <i>ES-DO</i>
10	7/31/19	Aligned HPSB and LEED requirements to NNSA Federal Green Buildings Training, stressed Smart Labs, other minor changes throughout. Updated Attachment 1.	Tobin Oruch, <i>ES-FE</i>	Jim Streit, <i>ES-DO</i>

**CONTACT THE SUSTAINABLE DESIGN STANDARDS POC
for upkeep, interpretation, and variance issues**

ESM Ch. 14	Sustainable Design POC / Committee
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1.0 Acronyms

EPP	environmentally preferable products
FEMP	Federal Energy Management Program (DOE organization behind DOE-specific energy mandates)
GP	Guiding Principles of the HPSB Program; a high-level list with compliance governed by the checklists discussed below
HPSB	High-performance, sustainable building. Federal buildings that achieve a level of sustainability defined by checklists.
IEBC	International Existing Building Code, published by the International Code Council
IECC	International Energy Conservation Code, published by the International Code Council
LCC	Life Cycle Cost
LEED	U. S. Green Building Council's <i>Leadership in Energy and Environmental Design (LEED)</i> green building rating systems
SD	sustainable design (or green building)

2.0 Requirements

NOTE: The project impact of this chapter can be significant and warrants review early in the project planning and programming phases.

Various sustainable design drivers are applicable at different project scope thresholds. They are listed below, and details follow.

10 CFR 433	<i>Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings.</i> A pdf version is webposted as a reference for this chapter here .
10 CFR 436	<i>Federal Energy Management and Planning Programs</i> , includes lifecycle cost analysis method. A pdf version is webposted as a reference for this chapter here (with annual data update).
ASHRAE 90.1	ANSI/ASHRAE/IESNA 90.1, <i>Energy Standard for Buildings Except Low-Rise Residential Buildings</i> . Note: Depending on the requirement below, the invoked version may not be the latest.
DOE O 413.3	Program and Project Management for the Acquisition of Capital Assets
DOE O 436.1	Departmental Sustainability

TABLE 1. Major SD Requirement Applicability

Note: Each column heading refers to an article that follows table

Project Scope		Minimum Requirement(s)					
		IECC or 90.1	10CFR433	HPSB	LEED Gold	Efficient Labs	Green Purchasing
1	"Alteration" ¹ or "repair" of buildings and building systems	X					X
2	New (or additions to) office, lab, and other commercial-like buildings		X				X
3	Same as "2" but also over 5000 sq. ft.		X	X			X
4	Major renovation or modernization ² in facilities over 5000 sq. ft.	X		X			X
5	New buildings, major renovations, and additions over \$50M		X	X	X ³		X
6	Laboratories or fume hoods					X	X

A. **IECC or ASHRAE 90.1: Building and system alterations and repairs** meeting LANL versions of International Existing Building Code (IEBC) definitions of same¹ shall meet energy conservation requirements of the IEBC and IECC—see IECC’s Chapter 5 CE—or simply follow ASHRAE 90.1. When using the IECC, follow the more stringent of IECC and the New Mexico version of it (see ESM [Ch. 16](#) Section IBC-GEN Att A for editions and details on both).⁴

1. Design review: Documentation (calculations, product information, etc.) showing compliance with the IECC (or the underlying ASHRAE 90.1 requirements) shall be submitted for LANL acceptance.
2. Extensive alterations or modernization that includes comprehensive replacement or restoration of virtually all major systems (i.e., row 4 of table above involving modifications to all three of these major systems: HVAC, electrical, and roof/building envelope would conclude extensive modernization) must also meet the *Guiding Principles for Sustainable Federal Buildings*, see Guiding Principles section below.

¹ LANL-centric IEBC alteration definitions are in ESM Ch 16, [IBC-GEN](#) Form 1 Preliminary Project Determinations. Because IECC allows use of ASHRAE 90.1 for compliance, that is an option to following IECC.

² **Modernization:** Renovations that include a comprehensive replacement or restoration of virtually all major systems, interior work (such as ceilings, partitions, doors, floor finishes, etc.), and building elements and features. [from 2019 HPSB training].

³ Meeting LEED Gold will satisfy the majority of the HPSB mandate, but must also meet HPSB.

⁴ Most stringent required by ESM Chapter 1 Section Z10. When extensive modifications and new buildings meet the more stringent requirements (10CFR433 30% goal, LEED, etc.), compliance with IECC is automatic. 10CFR433 for new only.

B. Code of Federal Regulations: [10CFR433](#) (new construction only)

1. Design buildings and additions to meet 10CFR433.⁵ *At time of writing, this includes achieving energy consumption levels at least 30% below the levels of the ASHRAE 90.1-2013 Baseline Building.*⁶
 - If project believes that 30% is not life-cycle cost (LCC) effective, then this chapter's POC shall be consulted; given properly prepared LCC analysis, a reduction in this requirement will be allowed through a formal process (e.g., 2137 Variance form).
 - *Guidance: Access ASHRAE 90.1-2016 training slides here: <https://www.energycodes.gov/training>. Also, the 90.1 User's Manual is a 'must have' when addressing anything in the Standard.*

C. Guiding Principles (GP) for High Performance Sustainable Buildings (HPSB)

1. Ensure that new construction and major renovations (modernization)⁷ of buildings over 5000 sq. ft. comply with the [Guiding Principles for Sustainable Federal Buildings](#).
2. There are six required HPSB GPs for new construction and major renovations:
 - a. Employ Integrated Design/Assessment, Operation, and Management Principles
 - b. Optimize Energy Performance
 - c. Protect and Conserve Water
 - d. Enhance Indoor Environmental Quality
 - e. Reduce the Environmental Impact of Materials
 - f. Assess and Consider Climate Change Risks.⁸
3. The HPSB program is similar to LEED in terms of applying set criteria of energy and water efficiency principles to the siting, design, construction, and commissioning of new facilities and major renovations of existing facilities. Implementation steps:
 - a. [Review the HPSB GPs](#) in the project planning phase and determine necessary measures to achieve compliance. DOE has also developed [associated instructions](#) and checklists with recommendations for evaluating/tracking a building's progress toward meeting the HPSB GPs. Request the Excel checklist from site-sustainability@lanl.gov (*questions on LANL campus specifics to same address*).
 - b. Project completes the checklist during the design process and sends it to site-sustainability@lanl.gov for preview.
 - c. Prior to project closeout, sends the finalized checklist with documentation to site-sustainability@lanl.gov for final review and brokering approval by NNSA.

⁵ See link under References [webposted](#) with this chapter. Certain industrial (non-commercial) facilities (e.g., nuclear or processing) with once-through air HVAC might not cost effectively meet ASHRAE 90.1. Meeting above requirement supersedes and satisfies any other ESM chapter whole building requirements suggesting ASHRAE 90.1 latest edition is required. 433 green bldg. cert applies to new buildings and buildings undergoing major renovations of at least \$2.5M in costs (2007 dollars, adjust annually for inflation).

⁶ A revision to 433 is anticipated that will invoke 90.1-2016 and allow 12 months to implement same; in short, comply with latest CFR.

⁷ Includes joined transportables when over 5K ft². Major renovations definition: comprehensive replacement or restoration of virtually all major systems (i.e., modifications to all three of these major systems: HVAC, electrical, and roof/building envelope would constitute modernization.).

⁸ LANL should follow NNSA guidance on complying with this Guiding Principle. If there are questions, please contact the NNSA Green Buildings Program Manager (*Wayne Evelo, 505-845-5501, wayne.evelo@nnsa.doe.gov*).

4. Additional HPSB Guidance (offramp, etc.)
 - a. The GPs do not apply to buildings that:
 - 1) are 5,000 GSF or less,
 - 2) are leased,
 - 3) have a status indicator of ROE submitted or accepted, Determination to Dispose, or Surplus, or
 - 4) meet **all** of these conditions:
 - Unoccupied: The building is occupied 1 hour or less per person per day on average,
 - Low/No Energy Use: Total usage from all sources is less than 12.7 kBtu/GSF/year, and
 - Low/No Water Use: Consumption is less than 2 gal/day on average.
 - b. When over \$50M and achieving LEED Gold, HPSB GP compliance is also required (there are major similarities between LEED and HPSB; however, documentation that meets the GPs is also required).
 - c. There is no waiver process for HPSB.⁹

D. LEED: New buildings and major renovations and additions in excess of \$50M TEC:

Note: When over \$50M and achieving LEED Gold, HPSB GP documentation for compliance is also required.

1. At a minimum, all new construction and major building renovations must meet U.S. Green Building Council's LEED Gold certification (including registration, submission of documentation, verification, and installation of plaque).¹⁰ *Guidance: LEED version is dictated by USGBC based on registration date. New construction follows LEED BD+C; renovations may use LEED O+M with Chapter POC permission.*
 - a. **When LEED is mandated:** To better ensure successful verification, design and construct with the goal of achieving two or more credits than the minimum. Ref. www.usgbc.org. Project must have a plan (e.g., contract wording, etc.) for who will follow the project during and after construction and until LEED certification and plaque achievement is completed. *Guidance: The Project must decide which party will register with USGBC, pay fees, and submit documentation -- and contract for same if AE. ConsensusDOCS 310 Green Building Addendum is a useful reference in crafting subcontract language. Guidance: The LANL Operations and Infrastructure Program Office's Infrastructure Planning group can provide sustainability guidance -- e.g., providing awareness, information and direction on how to best meet LEED and DOE requirements. This, at times, will include opinions on the proper use of LEED, or not. They will not suggest relief from LEED and/or DOE requirements, in any form, for projects that are clearly intended for compliance.*
2. LEED Offramps
 - a. **When the Federal Project Management Executive (PME) supports the premise that LEED Gold cannot be reasonably achieved,** an approved waiver for LEED may be pursued. The process description for the waiver is posted as a chapter reference (directly [here](#)).

⁹ HPSB is required by DOE O 436.1. There are allowances for compliance if the GP is "not applicable" on a case-by-case basis; contact chapter POC.

¹⁰ [DOE O 413.3B](#) Chgs 4 and 5. Also applies to multiple new, collocated buildings where combined project cost meets threshold. Can be LEED for New Construction, Campus, etc. See USGBC [Rating System Selection Guidance](#)

- b. Minimum Program Requirements (MPRs): LEED is only applicable where project/building meets MPRs (For v4, was minimum 1000 gross square footage; complete, permanent building or space, and other criteria.).¹¹ Parking structures, exclusively process and power-generating buildings, and distribution systems are exempt.¹²
 - c. Renovations
 - 1) If planned renovations are less than either (i) 50% of building's aggregate gross square footage or (ii) TEC under 25% of the replacement value of the building, then LEED is not applicable.¹³
 - 2) If thresholds above are exceeded but the definition of **Major Renovation** from the USGBC selection [guidance](#) is seemingly not met, obtain formal interpretation (LANL Form 2176 or equivalent) regarding applicability of LEED per [ESM Ch 1 Section Z10](#).¹⁴
- E. **Efficient Labs:** When adding fume hoods or constructing new lab spaces, follow energy efficient laboratory design principles when safe and life-cycle-cost-effective; if judged not possible, document reasoning and submit to Chapter 14 POC for concurrence¹⁵.
1. Such projects shall consider using the Environmental Performance [Criteria](#) of International Institute of Sustainable Laboratories (I2SL) and the [Sustainable Strategies Checklist](#). The criteria and checklist will assist in meeting the required energy efficiency metric for HSPB GPs and 10CFR433 and includes these seven key elements:
 - a. Dynamic, direct-digital control systems
 - b. Real time demand-based ventilation to control air changes per hour
 - c. Efficient lighting (LEDs with occupancy sensors or timers)
 - d. Optimization or reduction of the exhaust fan discharge velocity (design study of exhaust dispersion based on site conditions)
 - e. Pressure drop optimization
 - f. Fume hood flow optimization: apply AIHA/ANSI Z9.5 Standard to analyze if fume hood standby ventilation can be reduced
 - g. Final commissioning and continuous commissioning with automated cross platform fault detection diagnostics (Guidance: fault detection diagnostic software is managed by UI FOD and is easily achievable with a digital control system on the yellow network).

¹¹ Failing to meet MPRs guarantees USGBC rejection. Square footage increased from USGBC's 1000 per DOE (Evelo) direction (consistent with 2010 SSP guidance for HPSB threshold, which is based on OMB grading per Begley, NA-161). Requirement of human occupancy no longer on website as of 5/2018.

¹² SNL practice adopted by LANL.

¹³ Projects below these thresholds would be rejected by USGBC. TEC of 25% from proposed 10CFR433 rulemaking published at 75 FR 29933. Floor area of 50% corresponds to an IEBC Level 3 Alteration and was also supported by the USGBC [Rating System Selection Guidance](#), Version 2, 11/24/10: "If a particular rating system is appropriate for 40% or less of the gross floor area of a LEED project building or space, then that rating system should not be used. If a particular rating system is appropriate for 60% or more of the gross floor area of a LEED project building or space, then that rating system should be used."

¹⁴ Projects not meeting this definition would be rejected by USGBC, who's 2010 Selection Guide defined **Major Renovation as:** "Includes extensive *alteration* work in addition to work on the *exterior shell* of the building and/or *primary structural components* and/or the core and peripheral MEP [mechanical/electrical/plumbing] and service systems and/or site work. Typically, the extent and nature of the work is such that the *primary function space* cannot be used for its intended purpose while the work is in progress and where a new certificate of occupancy is required before the work area can be reoccupied." Standards Program concurrence ensures consistent interpretation.

¹⁵ Achieving HPSB goals requires use of programs such as this, and SmartLabs is a LANL initiative in the FY19 Site Sustainability Plan (SSPP).

2. Refer to Lawrence Berkeley Lab's [Design Guide for Energy-Efficient Research Laboratories](#) for additional SD guidance.
3. In addition, LANL is an implementing partner of DOE's [Smart Lab Accelerator Program](#). The Smart Lab concept includes an integrated set of laboratory design criteria and performance standards that improves safety protocols and reduces energy consumption while offering continuous commissioning for real-time monitoring of facility conditions. The Utilities & Institutional Facilities' Sustainability Program [web page](#) has more information and [SME contacts](#).
4. [I2SL Best Practice Guides](#) (may have value for non-lab applications, too).

F. Green Purchasing/Environmentally Preferable Products (EPP)¹⁶

Sustainable acquisition, or "green purchasing," refers to purchasing products with specific environmental or energy attributes. The US Department of Energy (DOE) expects Los Alamos (along with all DOE sites, agencies and contractors) to purchase goods and services that can reduce environmental impact. Thus, projects/tasks must purchase [products with EPA, DOE and USDA environmental or energy-attribute recommendations](#) per the following approach.

1. Several LANL Master Spec sections have been revised to specify EPP products where appropriate.¹⁷ The project's design agency is responsible for using said direction. In addition, for the additional project spec sections created, the design agency shall refer to the listing of other EPP products in Attachment 1 and appropriately incorporate those EPP products as follows.
 - a. When considering these products during the development of the Specifications, use the following criteria so that **benefit to environment outweighs negatives in AE's judgment (and LANL concurrence via design review)**:
 - 1) Is not available at a reasonable price (code "CU"),
 - 2) Is not available competitively within a reasonable period of time ("DNI"), or
 - 3) Does not meet the Laboratory's performance standards ("DNMS").
 - b. An item other than the Attachment 1 recommendation may be purchased if the Att. 1 item¹⁸:
 - 1) Is not available at a reasonable price (code "CU"),
 - 2) Is not available competitively within a reasonable period of time ("DNI"), or
 - 3) Does not meet the Laboratory's performance standards ("DNMS").
 - c. Once an EPP product category is identified for a project, it is best to look directly at the [EPA's listing](#) to get an unfiltered/latest info on those items.
2. EPA's products supplier directory [here](#)
3. For recommendations, consult the Federal Green Construction Guide for Specifiers at [WBDG](#).
4. Additional resources:
 - a. GSA web link for green procurement compilation tool (account set-up not necessary): <https://vsc.gsa.gov/green/envAppliesProd.cfm>

¹⁶ Drivers: [DOE O 436.1](#), Departmental Sustainability; CRD requires a LANL EMS that protects the environment and enhances mission accomplishment. LANL [contract and ASM](#) requirements based on FAR, [Part 23](#) for requirements, [FAR 52.223-5 and other](#) clauses; [DEAR 970.5223-7](#) (POC and EPC-ES have details). Also, LANL EMS and FY19 SSPP included environmentally preferable purchasing commitment derived from [the DOE Sustainability Performance Office webpage](#): "Numerous Federal laws and regulations outline specific agency energy consumption, renewable energy, and water efficiency requirements. The DOE Federal Energy Management Program (FEMP) offers information on these [laws and regulations](#). SPO focuses on the following high-level requirements...Ensure 95% of new purchases and contracts meet sustainable procurement requirements..." FY19 SSPP stated: "Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts."

¹⁷ Including 03 3001 Reinforced Concrete; 22 4200 Plumbing Fixtures; 26 5100 Interior Lighting, etc. Attachment 1 will be updated periodically based on changing expectations by Ch 14 POC-only approval and without revision to chapter body.

¹⁸ Codes are needed for LANL-internal iProcurement system only per LANL Green Purchasing/Sustainable Acquisition [webpage](#).

- b. Fed Center guidance for sustainable acquisition (account is necessary for deep data dives): <https://www.fedcenter.gov/programs/buygreen/>
- c. Whole Building Design Specs: <https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs>
- d. EPA Greener Products and Services: <https://www.epa.gov/greenerproducts/identify-greener-products-and-services>
- e. LANL Green Purchasing / Sustainable Acquisition web page has this list of green office products available: <http://int.lanl.gov/environment/p2/sustainable/epp.shtml>

G. Other SD Requirements

1. **Life Cycle Cost (LCC):** When energy performance design criteria aren't prescriptive such as is the case with aspects of some drivers (e.g., IECC, 10CFR433), design for lowest life-cycle cost. Life cycle cost analysis, when required, shall be performed per 10CFR436 (*Guidance and references in/with ESM Ch. 1 Z10 App E*). For example, when building a parking garage, photovoltaic panels on the roof shall be considered for energy generation unless not life cycle cost effective.
2. Ensure all new **roofs** have a thermal resistance of at least R-30. Install cool roofs for new construction or when replacing roofs unless determined uneconomical by a life-cycle cost analysis. [Secretarial Memo of June 1, 2010]
3. Install **solar hot water** supply in new buildings and major renovations if life-cycle cost effective).¹⁹ Normally, buildings that use natural gas for water heating will not find life-cycle cost effectiveness with solar hot water. Contact mechanical or SD chapter POCs for guidance which may preclude the need to calculate.
 - a. Use the FEMP solar hot water calculator when performing initial simple payback analysis; use Albuquerque for nearest city. If simple payback period is greater than 24 years, solar water heating is not cost effective.
 - b. Follow IAPMO *Uniform Solar Energy Code (USEC)*, edition and amendments per ESM [Chapter 16](#) Section IBC-GEN Attachment A, *LANL Building Code*.
4. Develop and follow a **Waste Minimization Plan**. Develop prior to construction start and follow throughout project. *The goal is that constructor recycle or salvage at least 50 percent of construction, demolition and land clearing waste, excluding soil, where markets or on-site recycling opportunities exist. Architectural POC may have examples.*
5. Edit LANL Master Spec Section [01 8113.13 Sustainable Design](#) to include applicable requirements and include in Project Specification where appropriate.

3.0 Appendices

- A. Guidance for SD

4.0 Attachments

Attachment 1, *Environmentally Preferable Products for Design Agency Created Specifications*

¹⁹ Energy Independence and Security Act (EISA 2007) Section 523, through amendment of the Energy Conservation and Production Act, states, "if lifecycle cost-effective, as compared to other reasonably available technologies, not less than 30 percent of the hot water demand for each new Federal building or Federal building undergoing a major renovation be met through the installation and use of solar hot water heaters." Z10 design goal references give a 24-year life for a heat exchanger.

Appendix A – Guidance for SD

1. Designing, constructing, and operating facilities in an efficient and environmentally sound manner is important to LANL. This approach to building design, construction, and operation is commonly referred to as sustainable (or green building) design and development (SD). The primary objectives of SD are to:
 - A. minimize, during design, the anticipated waste generation and resource consumption of a facility in all of its life cycle phases: construction, operation, closure, and disposition,
 - B. provide, during design and construction, for the comfort, productivity well-being of building occupants,
 - C. decrease operating and maintenance costs,
 - D. limit, during design, operation, and construction, facility impacts on the surrounding environment and environmental processes (such as the water cycle).
2. It is LANL's goal to apply sustainable design and development principles to all new buildings, additions, and HVAC renovation projects to provide a healthful, resource-efficient and productive working environment. To achieve this goal requires an awareness of and a commitment to sustainable design through an integrated, whole-building design approach.
3. The [LANL Sustainable Design Guide](#) (posted with ESM Ch 4) was created in 2002 to provide guidance on incorporating sustainable building strategies and technologies on LANL-specific projects. Although dated, the principles in this guide are still applicable and provide a starting point for further research into design strategies that can be conducted on-line, for example, the [Whole Building Design Guide](#) (a program of the National Institute of Building Sciences) has an excellent web resource: <http://www.wbdg.org/design-objectives/sustainable>.
4. ASHRAE offers Zero Energy, 30%, and 50% Advanced Energy Design Guides for **Small and Medium Office Buildings and Warehouses** [here](#), some with tech support docs.
5. **Large office buildings** 50% energy savings [technical report](#) recommendations.
6. For **efficient labs**, see <https://www.wbdg.org/resources/sustainable-laboratory-design> and NREL Site Operations Smart Labs Design Guidelines are posted as a reference with this chapter.
7. The DOE et al. has released a report titled "[Contrasting the Capabilities of Building Energy Performance Simulation Programs](#)." The report discusses 20 energy-modeling computer programs: BLAST, BSim, DeST, DOE-2.1E, ECOTECT, Ener-Win, Energy Express, Energy-10, EnergyPlus, eQUEST, ESP-r, HAP, HEED, IDA ICE, IES <VE>, PowerDomus, SUNREL, Tas, TRACE, and TRNSYS. Drawing from information provided by the program developers, the report compares the programs' handling of a range of parameters, including daylighting, renewable energy systems, and climate data availability.
8. The [LEED](#) Rating System also has LEED-Multiple Buildings and On-Campus Building Projects, a certification and application guide that provides direction in applying LEED to projects in a campus or multi-building setting, such as corporate campuses, college campuses, and government installations (i.e. a single owner or common property management and control). It is intended for projects where a) several buildings are constructed at once or in phases, or b) a single building is constructed in a setting of existing buildings with common ownership or planning with the ability to share amenities or common design features.
9. Data center projects should consider Best Practices Guidelines and other materials at <https://datacenters.lbl.gov/>.
10. New Buildings Institute's ([NBI](#)) Advanced Buildings initiative has a number of free resources for energy reduction through its PowerYourDesign.com [website](#). NBI's Core Performance method may be employed for LEED credits, however, modeling may be required anyway due to 10CFR433.
11. NIBS SD site: <https://www.nibs.org/page/facilityperformance>

12. The DoD approach: "[UFC-1-200-02](#) provides minimum requirements and guidance to achieve high performance and sustainable facilities that comply with the *Energy Policy Act of 2005*, the *Energy Independence and Security Act of 2007*, *EO 13693*, and the implementation requirements found in "*Guiding Principles for Sustainable Federal Buildings and Associated Instructions*" (HPSB Guiding Principles). This UFC is organized around the HPSB Guiding Principles. Per DOD *Sustainable Buildings Policy*, when a building meets the requirements of this UFC, it is considered compliant with the HPSB Guiding Principles. ASHRAE 90.1 *Energy Standard for Buildings Except Low-Rise Residential Buildings* applies to all projects (except low-rise residential which must comply with IECC) in its entirety. ASHRAE 189.1 *Standard for the Design of High-Performance Green Buildings* is an industry standard created to consolidate and address sustainability and energy requirements. This UFC incorporates the sections of ASHRAE 189.1 mentioned herein when appropriate and determined to be life cycle cost effective. Where the provisions of ASHRAE 189.1 meet the intent of the HPSB Guiding Principles, the provisions of ASHRAE 189.1 are referenced as a means of compliance or provided as an alternative compliance pathway. When other standards are referenced in ASHRAE 189.1, use the publication date of the standard referenced in Appendix A of [the UFC]."
13. Specific items for consideration as part of the sustainable design effort are referenced by specific discipline in other sections of the ESM. Additionally, key concepts and components of sustainable design, and suggested elements for consideration, are described below. The A/E is encouraged to suggest other measures and develop integrated solutions to meet the intent of sustainable design, and conduct a benefit/cost analysis of selected options. The A/E should coordinate with the ESM Discipline POCs with regard to green building materials, pollution prevention issues, and associated benefit/cost analysis. In all cases, it is essential to evaluate these items from a whole building (integrated) design approach (whole building design looks at how materials, systems and products of a building connect and overlap, and how the building and its systems can be integrated with supporting systems on its site and in its community). To demonstrate a commitment to LANL SD goals and objectives, the following strategies, as confirmed by the responsible LANL Project Manager, should be pursued for all new building and major renovation projects at LANL:
 - A. Adopt energy and environmental performance goals to minimize energy consumption and reduce environmental impacts. General Note: energy efficiency also includes the office products and appliances purchased for new facilities. LANL has historically had requirements to purchase Energy Star compliant equipment (covers offices, appliances, and conference rooms) <http://www.energystar.gov/>²⁰
 - B. Assess opportunities from a whole-building approach to maximize energy and water conservation through comprehensive, integrated evaluations of all components, systems, and, as appropriate, processes.
 - C. Use life-cycle-cost decision-making. See ESM Chapter 1 Section Z10 (App E) on LCC. Also consider FEDS 6.0, which calculates lowest life cycle cost-effective energy systems for all building types. www.pnl.gov/FEDS
 - D. Commission equipment and controls in all new construction and major renovation projects as an integrated effort during design and construction to verify building system performance and functionality for the Users and for Facilities operations and maintenance. Reference ESM [Ch 15, Commissioning](#).
 - E. Develop environmental performance objectives to minimize waste generation (low-level waste, hazardous waste, etc.) from the mission operations going into the new facility.
 - F. Employ a broad range of advanced energy and water efficiency strategies, including but not limited to central plant optimization, airside supply and exhaust distribution optimization, energy recovery methods, lighting design optimization, and water use reduction measures.
 - G. Site selection, minimizing site disturbance, and comfort and well-being of building occupants are covered in other areas of this document.

²⁰ DOE O 430.2B

- H. Measure energy and water consumption using direct digital control (DDC) monitoring systems or by other means if DDC not available.
- I. Enhance indoor environmental quality by including features such as daylighting, low emitting materials, indoor air quality protection measures and practices during the construction process, and controllability of individual occupant spaces for temperature, lighting, and air flow.