Department of Defense

Legacy Resource Management Program

PROJECT NUMBER 09-456

Maintaining Elements that are Efficient by Design (or What's Already Green About Our Historic Buildings)

Van Citters: Historic Preservation, LLC

JULY 2010

Authors
Karen Van Citters, CSI, CDT
William A. Dodge, Ph.D.
Timothy Sawyer, Ph.D.
Sarah R. Payne, Ph.D.
Modeling
Environmental Dynamics (ēdi)
Matthew Higgins

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Federal statutes, regulations, and guidance outline requirements for sustainability and increased energy efficiency for Department of Defense (DoD) buildings, as well as the continued use or adaptive use of historic buildings. Often these two concepts and the statutes, regulations, and guidance are in conflict. Exacerbating these conflicts is the prevailing perception that historic buildings are not or cannot be energy efficient. This project was developed to analyze the construction and design precepts of military buildings built between 1870 and 1989 to identify those elements of DoD historic buildings that are sustainable.

During the study, it became clear that individual historic building features may be characterized today as "green" or sustainable; but overall, historic buildings were designed to behave differently than modern buildings. As such, they should be analyzed as systems to determine the original functionality prior to developing retrofits in the name of sustainability. In many cases, retrofits that were completed to increase insulation values or energy efficiency actually reduced the effectiveness of the inherent characteristics of the historic building. The ultimate goal of this report is to educate DoD cultural resources managers, planners, engineers, maintenance staff, and other facilities staff about the existing sustainability of historic buildings and the need for a thorough historic preservation and sustainability analysis prior to making alterations. This can ensure that the requirements to meet federal laws for energy efficiency, sustainability, and the preservation of historic resources are all met.

ACRONYMS & ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
AIA	American Institute of Architects
AIRFA	American Indian Religious Freedom Act
AR	Army Regulation
ARPA	Archeological Resources Protection Act
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
BTUs	British Thermal Units
CDD	Cooling Degree Day
CBECS	Commercial Building Energy Consumption Survey
CFR	Code of Federal Regulations
CRM	Cultural Resource Manager, Cultural Resource Management
CRS	Congressional Research Service
DoD	Department of Defense
DOE	Department of Energy
DON	Department of the Navy
ECM	Energy Conservation Measure
ēdi	Environmental Dynamics, Inc.
EER	Energy Efficiency Ratio
EISA	Energy Independence and Security Act of 2007
EO	Executive Order
EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 2005
Et	Thermal Efficiency
EUIs	Energy Use Intensities
GSA	General Services Administration
HDD	Heating Degree Day
HVAC	Heating, Ventilation, and Air Conditioning
IEQ	Indoor Environmental Quality
IESNA	Illuminating Engineering Society of North America
ISE	Installation Support Directorate–Environment
kBtu	Kilo British Thermal Units
kWh	Kilowatt Hour
LED	Light-Emitting Diode
LEED	Leadership in Energy and Environmental Design
LPD	Light Power Density
Low-e	Low-emitting
MOU	Memorandum of Understanding
NAGPRA	Native American Graves Protection and Repatriation Act
NAVFAC	Navy Facilities Engineering Command

NHPA	National Historic Preservation Act
NIBS	National Institute of Building Sciences
NRHP	National Register of Historic Places
OMB	Office of Management and Budget
PL	Public Law
SEER	Seasonal Energy Efficiency Ratio
SHPO	State Historic Preservation Officer
USDA	U.S. Department of Agriculture
USAEC	U.S. Army Environmental Command
USGBC	U.S. Green Building Council
VCHP	Van Citters: Historic Preservation, LLC
WBDG	Whole Building Design Guide
W/sqft	Watts per square foot

1.0 INTRODUCTION

Legacy Project 09-456 was awarded to Van Citters: Historic Preservation, LLC (VCHP) in February, 2009 by the Department of Defense (DoD) Legacy Resource Management Program. The project was sponsored by Sue Goodfellow, Ph.D., Cultural Resources Specialist, U.S. Marine Corps Headquarters. As stated in the project proposal, the goal of the project was to analyze the construction and design precepts of military buildings constructed between 1870 (the beginning of the "modern" U.S. Army) and 1989 (the end of the Cold War era) to identify elements of DoD historic buildings that are sustainable by design. Recent federal statutes, regulations, and guidance set forth goals and requirements for sustainability and increased energy efficiency for DoD buildings. Other statutes and regulations encourage the preservation and continued use of historic buildings. The question of how compatible these two ideals are has become a hot topic of debate in recent years, and arguments range from, "there must be major modifications to old buildings for them to become sustainable," to, "historic properties are inherently sustainable." Is one side of the discussion more accurate than the other? Or does the answer lie somewhere in between?

Consider the following statements.

- Noted architect Carl Elefante, AIA, LEED AP, asserts:

  > *The green building movement remains blind to its most troubling truth: We cannot build our way to sustainability . . . Seeking salvation through green building fails to account for the overwhelming vastness of the existing building stock. . . . We cannot build our way to sustainability, we must conserve our way to it.*

- Executive Order 13287 states:

  > *It is the policy of the Federal Government to provide leadership in preserving America's heritage by actively advancing the protection, enhancement, and contemporary use of the historic properties owned by the Federal Government, and by promoting intergovernmental cooperation and partnerships for the preservation and use of historic properties.*

- The Energy Independence and Security Act of 2007 (EISA) calls for:
  - Reducing total energy use in federal buildings by 30% by 2015;
  - Federal energy managers to conduct a comprehensive energy and water evaluation for each facility at least once every four years; and
  - Major replacements of installed equipment (such as heating and cooling systems), or renovation or expansion of existing space, to employ the most energy efficient designs, systems, equipment, and controls that are life-cycle cost effective.
- The U.S. Energy Information Agency has pronounced that, "Buildings constructed before 1920 are more energy efficient than any constructed after 1920." [1]

Elefante underscores the fact that America's existing built environment is much too large to rely solely on new green buildings to significantly advance the cause of sustainability. This premise is supported by DoD statistics that show the agency is responsible for over 250,000 buildings.[2] Of this number, it is estimated that perhaps as many as 62,500 of these buildings are historic, that is, eligible for inclusion in the National Register of Historic Places (NRHP).[3] DoD policy follows the Presidential Executive Order quoted above, which states that historic properties embody the rich cultural heritage of the United States, including U.S. military history, and should be preserved and re-used whenever possible. The U.S. Congress has set goals for energy independence in federal (including DoD) buildings that potentially call for major renovations, which could come into conflict with accepted rehabilitation standards set forth by the historic preservation community.

---

[1] This data was referenced in the Executive Summary of testimony by Jean Carroon, FAIA, LEED , Principal, Goody Clancy, and a Member of the National Trust for Historic Preservation, on June 18, 2008, before for the Senate Committee on Rules and Administration. Her written statement is supported by data from the U.S. Energy Information Agency, "Consumption of Gross Energy Intensity for Sum of Major Fuels for Non Mall Buildings, 2003 (http://www.eia.doe.gov/emeu/cbecs2003/detailed_tables2003/ 2003set9/2003pdf/c3.pdf) and an unpublished paper written by Bradley Wolf, Donald Horn, and Constance Ramirez, "Financing Historic Federal Buildings: An Analysis of Current Practice," (Washington, D.C., General Services Administration, 1999). Attempts by VCHP to obtain a copy of this paper were unsuccessful.

[2] Maureen Sullivan, Director, Environmental Management, Office of the Deputy Undersecretary of Defense (Installations and Environment), DoD, personal communication, 2010.

[3] General Services Administration (GSA) has estimated that 25% of its 1,600 buildings are historic (www.gsa.gov). Since the DoD does not have a count for the number of historic buildings in its inventory, VCHP has used the GSA percentage for comparison.

Circulated among the historic preservation community, is the above pronouncement that buildings constructed before 1920 are the most energy efficient. This statement, however, remains questionable—particularly in light of the findings presented by the Energy Model case study in Chapter 6 of this study, which directly contradict this statement. The evidence that is used to support the contention that historic buildings are inherently energy efficient comes from data collected in the 2003 Commercial Building Energy Consumption Survey (CBECS) and from an unpublished, draft GSA paper, "Financing Historic Federal Buildings," created in 1999, which is unavailable to the public.[4] A summary of this paper in the National Trust for Historic Preservation's *Forum News* contends that "many older historic buildings in fact are more efficient and profitable than newer buildings."[5] This conclusion is much more modest than its exaggerated counterpart that *all* historic buildings built before 1920 are *always* more energy efficient than *any* constructed since. The "newer" buildings to which historic buildings were compared in the GSA paper were those constructed in the 1970s—considerable energy efficiency measures have been incorporated into new construction, especially in the last ten years, making the comparison of pre-1920 construction to post-1920 construction severely outdated at best, and of problematic use at worst. The GSA study also concluded that operating costs for historic buildings were less than those of non-historic buildings. This is an important point, as historic buildings *do* possess features that can aid in energy efficiency and overall sustainability (see Chapter 5). However, it is equally important to note that the lower operating costs of historic buildings in the GSA paper do not necessarily equate to what we would currently define as energy efficiency. In fact, as the case study presented in Chapter 6 reveals, it is very difficult to make enough energy conservation modifications to a typical historic building to raise its Target Finder rating to that of an Energy Star rating. The significance of these contradictions is that they reveal the danger of applying blanket statements to historic buildings. In this study, we advocate an approach that considers historic buildings, their sustainable features, and potential rehabilitation more thoroughly and systemically.

Given the facts that (1) the DoD has a large number of historic buildings in its inventory, (2) there is a generally unsubstantiated, but now almost mythical assertion that historic buildings are inherently energy efficient, and (3) preserving the historic qualities of these properties must be considered when planning renovations, can the DoD policy on preserving the historic built

---

[4] See footnote 1.

[5] Constance Ramirez, Donald R. Horn, AIA, and Bradley Wolf, "The Economics of Preserving Historic Federal Buildings," *Forum News* vol. 6, no. 1 (Sept./Oct., 1999).

environment mutually coexist with the federal mandate for energy conservation? The question posed in this study is: What is already "green" about historic buildings, and can these elements be incorporated into modern energy retrofits to improve their sustainability while at the same time preserving the historic architectural characteristics of the building?

Legacy Project 09-456 will:

- Identify the major regulations and policies outlined by the Federal government and DoD Service branches that affect sustainability and cultural resources, pointing out potential points of conflict;
- Analyze historic buildings from pre– and post–Heating, Ventilation, and Air Conditioning (HVAC) periods to identify the essential elements of historic building systems;
- Evaluate how the Whole Building Design Guide (WBDG) principles affect historic buildings;
- Identify, analyze, and discuss building components and features that contribute to sustainability, and provide tips on how these sustainable features can be capitalized upon in "green" rehabilitation projects;
- Demonstrate through computer modeling of an historic DoD building case study how much energy efficiency is attained when energy conservation measures are added to a building; and
- Offer key considerations when planning a retrofit project to an historic building meant to meet sustainability goals.

This study uses both quantitative and qualitative data. In addition, we follow three basic premises. First, historic DoD buildings, which in this study are those constructed from 1870 to 1989, fall into two broad groups: those constructed before modern HVAC systems were incorporated into buildings, and those constructed after (the chronological breaking point for this distinction is roughly the mid-1940s). Pre-HVAC historic buildings function very differently from the closed-system buildings that emerged after the advent and widespread use of mechanical heating and cooling systems. In this study, particularly in the sections that focus on sustainable building features and tips for rehabilitation, our focus is on pre-HVAC historic buildings. This is because, in general, post-HVAC buildings are not particularly sustainable as they use considerable amounts of energy to maintain interior conditions regardless of their environmental surroundings.[6]

[6] The finer distinctions of how pre- and post-HVAC buildings (or open and closed systems) operate are discussed in Chapter 3.

Second, historic buildings were designed to operate as a "system." The system is comprised of components and elements that contribute to its overall architectural style and which may be "sustainable" in the modern usage of the term. Underlying this premise is the assumption that buildings were constructed in such a way as to take advantage of specific construction techniques and designs, including the incorporation of what are now described as "green" building techniques, to operate as efficiently and effectively as possible.[7] Many historic buildings were never meant to function using the mechanical and technological systems that architects now routinely integrate into the design of modern buildings. A retrofit project designed to improve energy efficiency, therefore, may not always bring an historic property up to the currently accepted high performance standards. The system designer should understand how the particular building in question was originally intended to function, how it functions now, and how the energy and performance upgrades can be designed to meet realistic expectations, while at the same time preserving the building's historic fabric.

Third, energy efficiency and "green" standards are modern concepts that are not necessarily easily adaptable to historic buildings. Retrofitting historic buildings with modern energy-efficient equipment or materials may actually upset the operation of the building's original system, thus not only potentially damage character-defining features, but also result in the building operating less efficiently.[8] While earlier builders may have used "common sense" instead of "green standards" to construct a building, we would argue that to retrofit an historic building to meet modern design principles, while still maintaining its original stylistic features, is difficult at best and must be done keeping in mind that its original features—those that make the building historic in the first place—must be considered in any retrofit design in order to maximize the efficiency of the new system as well as maintain the building's historic qualities.

A nagging question throughout the data analysis phase of this project was: What is meant by "already green?" Prior to the late twentieth century, the concepts of "green buildings" and "sustainability" were either unknown or vaguely defined ideas. Architects and builders of the late nineteenth and early twentieth centuries certainly did not know these terms; however, this does not mean that they did not understand the principles driving these concepts. For example, U.S. Army records show that when Quartermaster Captain George Ruhlen designed the layout of Fort Bliss, just outside El Paso, Texas, in 1891, he was fully aware of some of the harsh climatic conditions of the local environment and therefore made modifications to the

[7] See Chapter 3 for discussion.

[8] "Character-defining features" are those design elements that convey a particular architectural style, and thus are important to preserve (for more discussion, see Chapter 5).

Quartermaster's standard plans for barracks. He oriented the long axis of the building north-south to avoid the hot temperatures created by a southern exposure. To compensate for the extreme summer temperatures that would be experienced by the western façade of the building, he built a porch along this entire elevation, while eliminating a matching porch on the east side in order to balance the need for shading and the need for daylighting. Ruhlen used "green" principles to provide as much comfort as possible for the enlisted men living in these quarters.[9]

Over the last thirty to forty years, the concept of "green" buildings and sustainability has become commonplace in the design world. The threat of dwindling natural resources has prompted an ethic of sustainability to be adopted by a coalition of planners, architects, and environmentalists in order to promote conservation of these resources. Many historic preservationists have rallied in support of sustainability by pointing out that the preservation of old buildings in itself is sustainable because it promotes re-use and the concept of embodied energy.

While various architectural groups, federal agencies, and private organizations have all provided a definition of what they consider a "green" building to be, the DoD has adopted general guidelines for use in providing leadership in sustainability practices. A Memorandum of Understanding (MOU) among federal agencies was developed by the National Institute of Building Sciences (NIBS) and included as a part of the online WBDG.[10] As part of the MOU, they adopted five guiding principles: (I) Employ Integrated Design Principles, (II) Optimize Energy Performance, (III) Protect and Conserve Water, (IV) Enhance Indoor Environmental Quality (IEQ), and (V) Reduce Environmental Impact of Materials. The widely accepted definition of sustainability as established by the 1987 U.N. World Commission on Environment and Development report "Our Common Future," and the definition we use in this report, is: "meeting the needs of the present without compromising the ability of future generations to meet their own needs." The most obvious connection between this definition of sustainability, the aforementioned MOU principles, and historic preservation would fall under Reducing Environmental Impact of Materials, as the retention and reuse of historic buildings preserves the materials, embodied energy, and human capital that has already been invested in the

[9] It should be noted that Ruhlen's ideas are only applicable for non-mechanical buildings. Current design principles, using modern HVAC systems, use the opposite principle of orientation to achieve maximum energy efficiency (Richard J. Reif, PE, personal communication, 2010).

[10] The guiding principles in the NIBS version of this MOU at the WBDG website are identical to those listed by the Federal Leadership in High Performance Buildings website, where a copy of the MOU and its signatories are posted, at http://www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=4713&destination=ShowItem

construction of historic buildings. This Legacy study, however, focuses on the ways that historic military buildings are sustainable beyond possessing significant embodied energy, particularly in regard to MOU principles (I), (II), and (IV). The term *green* is one which is much harder to define, as it is used in multiple contexts to mean varying things. However, *green* is often used interchangeably with *sustainable*, as it is in this study.

When this project was first conceived, VCHP expected to study a range of standardized military buildings from all branches of the armed forces. However, early on in the data acquisition phase of the study, we realized that we had made certain assumptions about military buildings that were not necessarily true. First, while standardized plans for temporary U.S. Army buildings (particularly those constructed during the first and second world wars) were generally built according to plan, permanent military facilities often underwent substantial design modifications prior to their construction, sometimes to the extent that there was little that was "standard" about them. In addition, buildings designed for the U.S. Navy rarely used standard plans, and, of course, the U.S. Air Force generally "inherited" their historic building inventory from the Army when it was created in 1947. Given the vast number (thousands) of standardized plans and amount of variation from these designs, it seemed fruitless to try and examine the entire range of plans. VCHP instead opted to focus on one standard plan building for which we had detailed historic drawings, to use that building as the case study to test our assumptions about the "greenness" of the building, and to draw conclusions about what elements of historic buildings contribute to sustainability and how these features can best be capitalized upon in rehabilitation projects.

The case study is a remodeled 1895 barracks building located at Fort McPherson, Georgia. VCHP teamed with the architectural firm of ēdi, Albuquerque, New Mexico, to develop a modeling concept that analyzes those architectural elements of the historic building that affect sustainability and energy conservation. The building, and its various modeling iterations, was analyzed using standards, calculations, and compliance requirements from the United States Green Building Council (USGBC's) Leadership in Energy and Environmental Design (LEED) rating system to determine overall energy performance. The objective of this analysis was to surmise how well historic buildings, as originally constructed, meet LEED standards.

Our final chapter in this study presents a new approach to meeting energy and sustainability goals in historic buildings. We believe that early in the design phase, architects and engineers need to thoroughly analyze the historic building's original design and understand how it operated as a system, then take into account those historic elements (character-defining features) that promote sustainability, and, applying the preservation measures listed in *The*

Secretary of the Interior's Standards for the Treatment of Historic Properties, design an updated system that will improve the building's "green" performance rating while preserving its historic characteristics.

VCHP intends for this report to serve as a tool for DoD cultural resources managers, planners, engineers, maintenance staff, and other facilities staff, providing information about the existing sustainability of historic buildings and the need for a thorough historic preservation and sustainability analysis prior to making alterations. This can ensure that the requirements to meet federal laws for energy efficiency, sustainability, and the preservation of historic resources are met. As is seen in the following pages, the answer to the question of "What is already green about historic buildings?" may be less definitive than we all would like. Perhaps a better way to conceive of the question is to ask what shade of green are historic buildings—what sustainable elements do they already possess—and how we can capitalize on those sustainable features to make historic buildings deeper shades of green.

2.0 REGULATIONS AND POLICIES AFFECTING DOD SUSTAINABILITY AND CULTURAL RESOURCE MANAGEMENT

Myriad regulations and policies guide federal building management, and those concerning sustainable practices and historic preservation take leading roles in the DoD's management of its building inventory. Those regulations and policies come from a broad range of laws, executive orders, and policy statements, each of which has detailed interpretive breakdowns within the overall DoD and within the military service branches (the United States Coast Guard has not been included in this study).

2.1 FEDERAL REGULATIONS GUIDING SUSTAINABILITY

The laws and executive orders that guide Federal sustainable facilities management include the following.

Executive Order 13423 (Strengthening Federal Environmental, Energy, and Transportation Management) was issued by President George W. Bush on January 24, 2007, and states that "It is the policy of the United States that Federal agencies conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient, and sustainable manner."[11] Several technical guides to implementing this executive order's directives are provided via the Federal Facilities Environmental Stewardship and Compliance Assistance Center.[12]

Executive Order 13514 (Federal Leadership in Environmental, Energy, and Economic Performance) was issued by President Barack Obama on October 5, 2009, and states that the federal government must lead by example and help create a "clean energy economy" by having Federal agencies "increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse and storm water management; eliminate waste, recycle, and prevent

[11] Section 1. Policy. Executive Order 13423, accessed at: <http://www.ntis.gov/pdf/EO13423.pdf>.

[12] Accessible at: <http://www.fedcenter.gov/programs/greenbuildings/#regs>. This web page includes links to the executive order implementation technical guides. It also includes a link to the Federal MOU in order to provide overall guidance for the sustainable construction and management of Federal buildings.

pollution; leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services; design, construct, maintain, and operate high performance sustainable buildings in sustainable locations; strengthen the vitality and livability of the communities in which Federal facilities are located; and inform Federal employees about and involve them in the achievement of these goals."[13]

Energy Policy Act of 2005 (EPAct) (Public Law [PL] 109-58) is an omnibus energy act signed by President Bush on August 8, 2005. It was spurred by rising energy prices and growing dependence on foreign oil. The new energy law was shaped by competing concerns about energy security, environmental quality, and economic growth. Title I of the EPAct is directly concerned with energy use in Federal buildings. This Act mandates (in Title I, section 109) that the Department of Energy (DOE) needs to set revised energy efficiency standards for new federal buildings at a level 30% stricter than industry or international standards—provided the standards would be "life-cycle cost-effective." Each agency's annual budget request is required to list all new federal buildings and whether or not each one meets these standards.[14] In addition, a section governing Energy Efficient Public Buildings (Title I, Sec. 125), mandates the establishment of a grant program for energy-efficient renovation and construction of local government buildings. The grants may be used for construction of new buildings that use 30% less energy than comparable public buildings that meet existing conservation standards and for renovations that reduce energy consumption by 30% over the pre-renovation baseline. DOE funding of $30 million per year was authorized for FY2006 through FY2010.[15]

Title II, Sec. 204, governs the use of photovoltaic energy in public buildings. GSA is authorized to encourage the use of solar photovoltaic energy systems in new and existing federal buildings. For FY2006 through FY2010, funding at $50 million per year is authorized for commercialization and $10 million per year is authorized for systems evaluation.[16]

Also part of the EPAct is a section addressing a Next Generation Lighting Initiative (Sec. 912). This section creates a DOE program to develop advanced white light-emitting diodes (LEDs) for high efficiency lighting. The LEDs are expected to be more efficient than incandescent and fluorescent lights. An additional section pertains to a National Building Performance Initiative (Sec. 913). The Department of Commerce, in coordination with the DOE, is directed to establish

[13] Section 1. Policy. Executive Order 13514, accessed at: <http://www.ntis.gov/pdf/EO13514.pdf>.

[14] Congressional Research Service (CRS) Report for Congress. Energy Policy Act of 2005: Summary and Analysis of Enacted Provisions, accessed at: <http://ncseonline.org/NLE/CRSreports/06Apr/RL33302.pdf>, p. CRS 7.

[15] Ibid., p. CRS 8.

[16] Ibid., p. CRS 13.

an interagency task group that would coordinate work among federal, state, and voluntary organizations to improve the energy efficiency performance of buildings. Finally, in a section on Building Standards (Sec. 914), the DOE is directed to work with the NIBS to prepare a report that assesses the effectiveness of voluntary building energy performance standards. The DOE is required to establish a program of technical assistance and grants to support revisions of existing standards.[17]

Energy Independence and Security Act (EISA) of 2007 (PL 110-140) is an "omnibus energy policy law that consists mainly of provisions designed to increase energy efficiency and the availability of renewable energy."[18] The law also establishes an Office of Federal High-Performance Green Buildings within the GSA. The important provisions are those under Subtitle C, "High-Performance Federal Buildings." Under this Subtitle, Section 431 mandates that Federal buildings become 30% more energy efficient by the year 2015. Section 432 mandates that building commissioning practices be employed to ensure that Federal buildings are energy efficient and that their systems work as designed. Section 433 mandates that fossil fuel consumption in new Federal buildings and in Federal buildings undergoing major renovations be reduced by 55% by the year 2010, and by 100% by 2030, compared to fossil fuel consumption in comparable Federal buildings in the year 2003. Section 433 also asserts that "Sustainable design principles shall be applied to the siting, design, and construction of such buildings."[19] In addition, it mandates that the Secretary of Energy shall identify a green buildings certification system for use in applying and enforcing sustainability standards in Federal buildings.

Section 434 of EISA mandates that the most energy efficient mechanical systems possible be used in replacement of existing HVAC systems in buildings. Section 435 mandates that Federal entities shall not lease buildings or space in buildings that have not achieved an Energy Star rating in the most recent year, or failing that, that after occupancy the building shall be renovated to achieve an Energy Star rating. Section 436 establishes the Office of Federal High-Performance Green Buildings. Section 437 implements an auditing program to ensure enactment of the mandates of the law. Section 438 regulates storm water flow requirements

[17] Ibid, Secs. 912-913, and 914, p. CRS 58.

[18] *Energy Independence and Security Act of 2007: A Summary of Major Provisions*, Fred Sissine, Coordinator, CRS, December 21, 2007: Order Code RL34294, p. 2.

[19] PL 110-140, H.R. 6, accessed at: <http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf, subsection III>, p. 122.

for new Federal buildings and major renovations; and Section 439 mandates implementation of a cost-effective technology acceleration program.

Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding stipulates that "signatory agencies commit to federal leadership in the design, construction, and operation of High-Performance and Sustainable Buildings. A major element of this strategy is the implementation of common strategies for planning, acquiring, siting, designing, building, operating, and maintaining High Performance and Sustainable Buildings."[20] The portion of the MOU called "Guiding Principles for Federal Leadership in High-Performance and Sustainable Buildings," consisting of five main principles, is incorporated as a central element of EO 13514 under section 2 (g). The MOU is discussed in more detail in the following chapter.

Office of Management and Budget (OMB) Circular No. A-11 contains a section that directly impacts the energy footprint of federal buildings. Section 300 stipulates:

> *The Federal Government must effectively manage its portfolio of capital assets to ensure scarce public resources are wisely invested. Capital programming integrates the planning, acquisition and management of capital assets into the budget decision-making process and is intended to assist agencies in improving asset management and in complying with the results-oriented requirements of:*
>
> > *The Energy Policy Act of 2005, Section 109, which requires that sustainable design principles are applied to the siting, design and construction of all new and replacement buildings and that new federal buildings be designed to achieve energy consumption levels that are at least 30 percent below the levels established in the 2004 International Energy Conservation Code for residential buildings or the ASHRAE Standard 90.1–2004 for non-residential buildings, if life-cycle cost-effective.*[21]

[20] Federal Leadership in High Performance and Sustainable Buildings MOU, accessed at: <http://www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=4713&destination=ShowItem>, p. 1.

[21] ASHRAE stands for American Society of Heating, Refrigerating, and Air Conditioning Engineers. OMB Circular No. A-11, section 300.3, accessed at: <http://www.whitehouse.gov/omb/assets/a11_current_year/a_11_2009.pdf>.

The section in OMB Circular No. A-11 does not deal directly with existing buildings, but the EPAct, as noted above, does specifically mention that existing Federal buildings need to reduce energy use at the same levels as those stipulated in the OMB Circular for new and replacement buildings.

2.2 POLICIES FOR DOD BRANCHES GUIDING SUSTAINABLE FACILITIES MANAGEMENT

Some military branches, in addition to the above-listed Federal mandates, also maintain their own policies on sustainable facilities management. These are described below.

2.2.1 UNITED STATES AIR FORCE

The "Air Force Sustainable Ops Policy Statement" is as follows:

> *It is Air Force policy to apply sustainable development concepts in the planning, design, construction, environmental management, operations, maintenance, and disposal of facilities and infrastructure projects, consistent with budget and mission requirements. A sustainable facility achieves optimum resource efficiency and constructability while minimizing adverse impacts to the built and natural environments through all phases of its life cycle. The goals of sustainable development are to conserve energy, water, and raw materials; prevent environmental degradation caused by construction, operations, and disposal of facilities; and create built environments which are livable, healthy, maintainable, and productive.*[22]

2.2.2 UNITED STATES ARMY

The Army's "Sustainable Design and Development Policy Update—Life-Cycle Costs—Department of the Army" contains the following sections:

> *2. Purpose. The purpose of this memorandum is to update the sustainable design and development (SSD) policy for Army facilities. Life-cycle cost analyses will be completed to determine the best capital asset investments to reduce the total ownership cost of*

[22] Air Force Sustainable Ops Policy Statement, accessed at: <www.homestead.afrc.af.mil/library/factsheets/factseet_print.asp?fsID=3457&page=1>.

facilities; improve energy efficiency and water conservation; provide safe, healthy and productive built environments; promote sustainable environmental stewardship; and reduce environmental impact/ footprint of operations in accordance with AR 415-15.

c. Existing Buildings. The Army is determining the appropriate rating level of LEED Existing Buildings and will issue additional policy once completed. In the interim, beginning in FY08, all major renovation and repair projects exceeding $7.5 million (requiring congressional notification) shall incorporate sustainable design features where life-cycle cost effective to achieve a minimum of the Certified level of the LEED Existing Buildings rating system. The Installation Director of Public Works or the Reserve Component equivalent, supporting Engineer District, designer of record, and/or the prime construction contractor will jointly verify the final LEED score and rating. USGBC certification is not required. [23]

The above mentioned Army Regulation (AR) 415-15 has since been incorporated in AR 420-01 as Chapter 4, “Army Military Construction and Nonappropriated-Funded Construction Program Development and Execution,” and AR 420-01 supersedes 415-15. Regarding renovations under Army military construction programs, AR 420-01, Appendix G, section G-2, states that:

b. Standard Design/Criteria are developed to ensure the specific needs, criteria, and functionality required by the Army functional proponent for a specific facility type are consistently provided through the incorporation of applicable Army Standards and the judicious application of sound engineering principals in the design process. Standard Design/Criteria are drawings and/or written criteria that delineate space allocations, functional layouts, and basic configuration of a facility that must be used in developing design and construction drawings for a specific project. They include the mandatory criteria that must be included when adapting the design to specific sites. Standard Design/Criteria must be followed for the design, construction, or major renovation of all similar facilities but are developed to allow limited flexibility to meet the needs of local conditions. Standard Design/Criteria are implemented through the DA Facilities Standardization Program, are maintained by the designated Center of Standardization for that facility type, and are disseminated through the Army Installation Design

[23] Sustainable Design and Development Policy Update—Life-Cycle Costs—Department of the Army, distributed April 27, 2007, accessed at: <www.sustainability.army.mil/tools/docs_leeds/OASA(IE)%20sustainable%20design% 20policy%20 (27%20Apr%2007).pdf>.

Standards (IDS) Web site. Exceptions to the use of mandated criteria in a Standard Design/Criteria must be obtained from the Army Facilities Standardization Subcommittee (AFSC) (see para G–4). [Paragraph G-4 governs the process by which a waiver can be obtained on the mandatory standardization of properties according to Army Standardization requirements.][24]

AR 420-01 also contains a section specifically addressing World War II temporary buildings. It states:

2–13. World War II temporary buildings

a. The Army considers WWII temporary buildings as functionally inadequate and uneconomical as long-term solutions to mission requirements, except for selected intermittent uses such as annual training. The Army goal is to eliminate most WWII temporary buildings on Active Army garrisons.

b. All work on WWII temporary buildings will be governed by requirements for facilities use, economic considerations, and good engineering judgment. The WWII temporary buildings will not be renovated to satisfy Base Realignment and Closure actions, unit stationing or realignments, new unit activations, or other projected missions.

c. If the total of all maintenance, repair, and alteration costs in a WWII temporary building project exceeds $40 per square foot, approval by the Garrison Commander is required. This requirement applies to all WWII temporary buildings, regardless of current use and project funding source. Project approval stated elsewhere in this regulation apply.

d. Garrison Commander will not delegate approval authority for projects concerning WWII temporary building whose costs exceed $40 per square foot.[25]

2.2.3 UNITED STATES MARINE CORPS

The United States Marine Corps policy on sustainability is as follows:

One of the primary focuses of environmental stewardship within the DoD is the concept of sustainability. Through conservation, improved maintainability, recycling, reduction

[24] AR 420-1, accessed at: <http://www.apd.army.mil/pdffiles/r420_1.pdf>, p. 392.
[25] AR 420-1, accessed at: <http://www.apd.army.mil/pdffiles/r420_1.pdf>, p. 10.

and reuse of waste, and other actions and innovations, the Marine Corps can meet today's needs without compromising the ability of future generations to meet their own. Refer to section 8205 for specific associated policies and requirements.[26]

Section 8205 further expands on the concept of sustainability as it is observed and enforced within the Marine Corps. It states:

The Federal government encourages agencies to take the lead in being stewards of the environment, to preserve today's resources for the future. One of the primary focuses of environmental stewardship within the DoD is the concept of sustainability; this concept applies to design, construction, operations, and resource conservation. Sustainability is responsible stewardship of the nation's natural, human, and financial resources through a practical and balanced approach. Sustainable practices are an investment in the future. Through conservation, improved maintainability, recycling, reduction and reuse of waste, and other actions and innovations, the Marine Corps can meet today's needs without compromising the ability of future generations to meet their own. Applying sustainability principles to cultural resources management, chapter 4 of reference (y), notes that "sustainability has often been an integral part of the composition of both tangible and intangible cultural resources. Ecological sustainability and preservation of cultural resources are complementary. In large part, the historic events and cultural values that are commemorated were shaped by humankind's response to the environment. When a cultural resource achieves sufficient importance that it is deemed historically significant, it becomes a nonrenewable resource worthy of consideration for sustainable conservation. Management, preservation, and maintenance of cultural resources should be directed to that end."[27]

2.2.4 UNITED STATES NAVY

The United States Navy's policy statement, issued June 9, 2003, is as follows:

a. Reduce the life-cycle cost of shore facilities by incorporating sustainable development concepts and principles in the planning, programming, design, construction, operation and maintenance, sustainment, restoration and modernization of all facilities and

[26] Accessed at: <http://www.marines.mil/unit/logistics/Documents/LFL/LFL-1/CulturalResources/Policy/Marine%20Corps%20Order%205090.2A,%20Chap_8_Change_2_Final.pdf>, p. 8-8.
[27] Ibid., p. 8-28 – 8-29.

infrastructure projects to the fullest extent possible, consistent with mission, budget, and client requirements.

b. NAVFAC [Navy Facilities Engineering Command] shall use the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED^{TM}) Green Building Rating System (http://www/leedbuilding.org) as a tool in applying sustainable development principles and as a metric to measure the sustainability achieved through the planning, design, and construction processes.[28]

2.3 FEDERAL REGULATIONS GUIDING HISTORIC PRESERVATION

As with sustainability, there are laws and regulations that guide historic preservation practices at Federal facilities, and then there are specific policy statements within military service branches. The following laws and policies guide historic preservation practice at all Federal facilities, and they also help inform policy within the specific Service branches.

The National Historic Preservation Act (NHPA) of 1966, as amended, is the guiding force behind federal historic preservation policy (16 U.S. C. 470). The law guides preservation policy both within and outside of the Federal government. In Section 1(b), the Act states in part:

- The spirit and direction of the Nation are founded upon and reflected in its historic heritage;
- The historical and cultural foundations of the Nation should be preserved as a living part of our community life;
- Historic properties significant to the Nation's heritage are being lost or substantially altered, often inadvertently, with increasing frequency;
- The preservation of this irreplaceable heritage is in the public interest so that its vital legacy of cultural, educational, aesthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Americans.[29]

The *Secretary of the Interior's Standards for the Treatment of Historic Properties* contains four important approaches to the treatment of historic properties.[30] They are regarded in the

[28] NAVFAC INSTRUCTION 9830.1, accessed at: <http://www.wbdg.org/pdfs/navfacinst_9830_1.pdf>.

[29] National Historic Preservation Act of 1966, as amended in 2006, accessed at: <http://www.achp.gov/docs/nhpa%202008-final.pdf>.

historic preservation community as a kind of ranked hierarchy, with the first, "Preservation," listed as the most preferable approach in the treatment of historic properties, since it adheres most strictly to the preservation of existing historic buildings and their historic character-defining features. "Reconstruction," the wholesale recreation of a building or site from scratch in the event of the destruction or demolition of a historic property, is the least preferable option. The four approaches are:

- *Preservation*: involves maintaining the property's existing form and materials, with very minimal changes. Although upgrading mechanical, electrical, and plumbing systems are permitted, additions to the building are not usually allowed under this standard. The property usually retains its integrity by continuing its original use, e.g., an historic house continues to be used as a house. In general, the Preservation standard allows very little flexibility with regard to materials, use, and form.
- *Rehabilitation*: involves the compatible use for a property through repair, alterations, building code upgrades, and additions while preserving those character-defining features that convey its historical, cultural, or architectural values. In general, the Rehabilitation standard recommends preserving distinctive materials, features, and building characteristics, repairing rather than replacing historic features, and permits building additions or exterior alterations so long as the character-defining features of the building are not destroyed.
- *Restoration*: involves selecting a specific time period in the building's history and making the building look as it did at that time. This may include removing additions and features from other periods of time, and restoring features that had been removed.
- *Reconstruction*: involves the new construction of all or part of a building or structure that no longer exists. The new construction replicates the appearance of the property a specific period of time and in its historic location.[31]

Executive Order 13287 was issued by President George W. Bush on March 3, 2003. It states:

> *It is the policy of the Federal Government to provide leadership in preserving America's heritage by actively advancing the protection, enhancement, and contemporary use of the historic properties owned by the Federal Government, and by promoting intergovernmental cooperation and partnerships for the preservation and use of historic*

[30] *The Secretary of the Interior's Standards for the Treatment of Historic Properties, With Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings.* Kay D. Weeks and Anne E. Grimmer (U.S. Department of the Interior, National Park Service, Washington, D.C., 1995).

[31] *The Secretary of the Interior's Standards for the Treatment of Historic Properties*, accessed at: <www.nps.gov/history/hps/tps/standguide/>.

properties. The Federal Government shall recognize and manage the historic properties in its ownership as assets that can support department and agency missions while contributing to the vitality and economic well-being of the Nation's communities and fostering a broader appreciation for the development of the United States and its underlying values. Where consistent with executive branch department and agency missions, governing law, applicable preservation standards, and where appropriate, executive branch departments and agencies ("agency" or "agencies") shall advance this policy through the protection and continued use of the historic properties owned by the Federal Government, and by pursuing partnerships with State and local governments, Indian tribes, and the private sector to promote the preservation of the unique cultural heritage of communities and of the Nation and to realize the economic benefit that these properties can provide. Agencies shall maximize efforts to integrate the policies, procedures, and practices of the NHPA and this order into their program activities in order to efficiently and effectively advance historic preservation objectives in the pursuit of their missions.[32]

2.4 POLICIES OF DOD BRANCHES GUIDING HISTORIC PRESERVATION

Beyond Federal regulations, each Service within the DoD has iterated its own policy on historic preservation and cultural resource management (CRM).

2.4.1 UNITED STATES AIR FORCE

The United States Air Force's policy on CRM is presented in more than one document, but the most comprehensive statement seems to be offered through the Air Force Center for Engineering and the Environment, where several documents are available to the public, and one in particular offers the most comprehensive overview on historic preservation.[33] This document is Draft AF Pamphlet 32-XXXX, Guidelines for Managing Cultural Resources[34], which is

[32] Executive Order 13287, accessed at: <www.gsa.gov/Portal/gsa/ep/contentView.do?P=PLAE&contentType=GSA_BASIC&contentId=16910>.

[33] The Air Force Center for Engineering and the Environment website that offers cultural resource management guidance can be accessed at: <www.afcee.af.mil/resources/conservation/cultural/index.asp>.

[34] Draft AF Pamphlet 32-XXXX, Guidelines for Managing Cultural Resources, accessed at: <www.afcee.af.mil/shared/media/document/AFD-070828-059.doc>.

an online draft statement issued by the Secretary of the Air Force outlining policies and goals for Air Force Cultural Resource Management (CRM).

> *1.2. Mission Statement: Management of cultural resources is an integral part of the Air Force mission. The CRM Program strives to balance managing and preserving the important historic and prehistoric heritage of the United States in concert with timely and efficient support of the Air Force military mission.*
>
> *1.3. Goals:*
>
> *1.3.1. The Air Force will identify, manage, and maintain its important cultural resources in the spirit of stewardship for the benefit of this and future generations of Americans.*
>
> *1.3.2. The Air Force will seek to balance the needs of its primary military mission with those of cultural resources.*
>
> *1.4. Policy: The Air Force Cultural Resources Management Program, outlined in AFI 32-7065, is designed to comply with applicable statutes and regulations, and meet those requirements in concert with the military mission. The Air Force defines cultural resources as **historic properties** (defined in the National Historic Preservation Act [NHPA]), **cultural items** (defined in the Native American Graves Protection and Repatriation Act [NAGPRA], **archaeological resources** (defined in the Archaeological Resources Protection Act [ARPA]), **sacred sites** (defined in E0 13007, Indian Sacred Sites, to which access is provided under the American Indian Religious Freedom Act [AIRFA]), and **collections** (defined in NHPA Section 101(a)(7) and Title 36 Code of Federal Regulations [CFR] Part 79, Curation of Federally Owned and Administered Archaeological Collections).*

Under section 1.5 of the same document are listed several laws that help govern U.S. Air Force CRM activities. They are the Antiquities Act of 1906 (16 USC 431-433), the Historic Sites Act of 1935, as amended (16 USC 461-467), the Federal Records Act of 1950 (FRA) (44 U.S.C. 2101-2118, 2301-2308, 2501-2506, 2901-2909, 3101-3106, 3301-3324) as implemented by 36 CFR Part 1222-1238, and the NHPA of 1966 as amended (16 U.S.C. 470-470m); as implemented by 36 CFR Parts 60, 61, 63, 65, 68, 78, 79, 800.

2.4.2 UNITED STATES ARMY

The United States Army policy on CRM (as detailed on the Advisory Council on Historic Preservation [ACHP] website detailing some DoD preservation policies) is as follows:

The Army is dedicated to pursuing innovative policies, programs, and initiatives to improve cultural resources management. Responsibility for cultural resources management at the Army headquarters level resides in two offices: the Office of the Assistant Chief of Staff for Installation Management's Installation Support Directorate – Environment (ISE), and the US Army Environmental Command (USAEC). ISE is responsible for promulgating cultural resources policy and guidance, while USAEC is the center for technical expertise. Most Army installations also have qualified cultural resources personnel on staff.[35]

The detailed breakdown of the Army's CRM policies is contained in Army Regulation 200-1. Within AR 200-1 is the following overarching policy statement on cultural resources:

6-1. Policy: Ensure that installations make informed decisions regarding cultural resources under their control in compliance with public laws, in support of the military mission, and consistent with sound principles of cultural resources management (AR-200-1, p. 28).[36]

2.4.3 UNITED STATES MARINE CORPS

United States Marine Corps policy on historic preservation is as follows:

In accordance with….DoD policy, the Marine Corps is responsible for managing and maintaining cultural resources under its control through a comprehensive program that considers the preservation of their historic, archaeological, architectural, and cultural values, is mission-supporting, and results in sound and responsible stewardship. Through the integration of its cultural resources management policies and procedures with Marine Corps mission, the Marine Corps will provide stewardship of cultural resources in a sustainable manner that supports the mission and promotes the quality of life for stakeholders.[37]

[35] Accessed at: <www.achp.gov/army.html>.
[36] Accessed at www.army.mil/usapa/epubs/pdf/r200_1.pdf>.
[37] Accessed at: <http://www.marines.mil/unit/logistics/Documents/LFL/LFL-1/CulturalResources/Policy/Marine% 20Corps%20Order%205090.2A,%20Chap_8_Change_2_Final.pdf>, p. 8-16.

2.4.4 UNITED STATES NAVY

The U.S. Navy's policy statement on the management of cultural resources is contained in a document issued by the Office of the Secretary of the Navy called SECNAV INSTRUCTION 4000.35A. In it are the following relevant policy statements:

> *5. Policy*
>
> *a. The DON* [Department of the Navy] *is a large-scale owner of historic buildings, structures, districts, archeological sites and artifacts, ships, aircraft, and other cultural resources. Protection of these components of the nation's heritage is an essential part of the defense mission; the DON is committed to responsible cultural resources stewardship. Ownership of archeological and historic artifacts recovered on property under control of the DON remains in DON by law.*
>
> *b. Preservation considerations will be incorporated into routine DON management of historic buildings, structures, districts, sites, ships, aircraft and other cultural resources. Compliance with cultural resource protection requirements will be incorporated as appropriate into other DON planning processes, including but not limited to master planning, environmental planning, budgeting/programming, and facilities management. When functionally appropriate and economically prudent, DON will give preference to the rehabilitation or adaptive use of historic properties over new construction or leasing.*
>
> *h. DON policy is to integrate to the fullest extent possible the procedures of Section 106 of [The National Historic Preservation Act of 1966] and of [the National Environmental Policy Act of 1969, U.S.C. 4321]* [38]

2.5 IMPLICATIONS OF REGULATIONS, POLICIES, AND DOD MISSIONS

The DoD and specific military service branches attempt to work with both historic preservation standards and sustainability standards listed above, while also maintaining their military mission. Potential conflicts can arise for DoD installations attempting to reconcile the various policies and laws.

[38] Accessed at: <http://doni.daps.dla.mil/directives/04000%20logistical%20support%20and%20services/04-00%20general%20logistical%20support/4000.35a.pdf>.

For example, the Army's stated policy that its World War II Temporary Buildings, of which there are still many on Army bases throughout the nation, are outdated and should be replaced, ignores the historic preservation potential of these resources.[39] According to the policy, "[t]he Army considers WWII temporary buildings as functionally inadequate and uneconomical as long-term solutions to mission requirements, except for selected intermittent uses such as annual training. The Army goal is to eliminate most WWII temporary buildings on Active Army garrisons." As these are all buildings that are greater than fifty years in age, they should be examined in relation to the provisions of the NHPA of 1966. Whether these buildings can be adaptively reused and made sustainable in keeping with the Army's Sustainable Design and Development Policy Update is not clear and will depend on the specific resources, their building material and siting, HVAC systems, etc.

The NHPA of 1966 states, in part, that "[t]he historical and cultural foundations of the Nation should be preserved as a living part of our community life," and that "[h]istoric properties significant to the Nation's heritage are being lost or substantially altered, often inadvertently, with increasing frequency."[40] The Army's stated policy toward World War II Temporary Buildings is at direct odds with its own policy to abide by the mandates of the NHPA, since a significant number of these buildings have played a role in important events in the nation's history, particularly given the role of World War II in shaping the nation's current status as an unrivalled superpower.

The Army also has a policy regarding renovations under Army military construction programs, AR 420-01, Appendix G, section G-2.[41] This policy governs the Army's Standard Design/Criteria, which were "developed to ensure the specific needs, criteria, and functionality required by the Army functional proponent for a specific facility type are consistently provided through the incorporation of applicable Army Standards and the judicious application of sound engineering principals in the design process." The application of Standard Design/Criteria applies not only to new construction but also to major renovations of existing buildings. One of the stipulations of the policy is that "Standard Design/Criteria must be followed for the design, construction, or major renovation of all similar facilities but are developed to allow limited flexibility to meet the needs of local conditions." It is unclear whether Standard Design/Criteria regarding major renovations would allow for leeway in incorporating sustainability principles or preserving character-defining features, but the caveat allowing for "limited flexibility to meet the needs of

[39] AR 420-1, accessed at: <http://www.apd.army.mil/pdffiles/r420_1.pdf>, p. 10.
[40] NHPA of 1966, as amended in 2006, accessed at: <http://www.achp.gov/docs/nhpa%202008-final.pdf>.
[41] AR 420-1, accessed at: <http://www.apd.army.mil/pdffiles/r420_1.pdf>, p. 10.

local conditions" does imply that there might be some room for play, although this caveat does read as if it may govern such considerations as climate, availability of local materials, etc.

Another area in which there is strong potential for conflict among various policies is where the primary mission of a military service branch, which is to provide defense to the nation and its assets, could possibly be "encumbered" by historic preservation needs and sustainability measures. Should an historic area or building site at a military installation be needed for another facility or for a mission not in keeping with the historic resource's current configuration, service mission and historic preservation will be at odds. It is, however, possible that such conflicts can be adjudicated by installation personnel, including cultural resources managers and representatives of the installation's command hierarchy, in consultation with a State Historic Preservation Officer (SHPO) or with the ACHP.

It is explicitly stated in Army Regulation 200-1 under section 6-4 that a major program goal for the Army is to "[d]evelop and implement procedures to protect against encumbrances to mission by ensuring that Army installations effectively manage cultural resources."[42] In fact, it is implied in many DoD branch documents that encumbrances to mission are first and foremost to be avoided. Although never openly stated, the DoD and its service branches, with the possible exception of the Navy (see below), do imply in policy statements that other considerations besides mission are secondary, including historic preservation and sustainability. The language also implies that CRM should be undertaken in such a way as to anticipate and forestall contradictions between primary mission, historic preservation, and sustainability objectives.

Army sustainability statements are concerned not only with reducing the environmental impact of facilities but also "life-cycle costs," making sustainability as much a matter of cost efficiency in the Army's view as it is about preserving the environment, conserving resources, and undertaking energy efficiency measures. The Army's policy statement is that "[l]ife-cycle cost analyses will be completed to determine the best capital asset investments to reduce the total ownership cost of facilities; improve energy efficiency and water conservation; provide safe, healthy and productive built environments; promote sustainable environmental stewardship; and reduce environmental impact/ footprint of operations."[43]

---

[42] Accessed at: <www.army.mil/usapa/epubs/pdf/r200_1.pdf>.

[43] Sustainable Design and Development Policy Update – Life-Cycle Costs – Department of the Army, distributed April 27, 2007, accessed at: <www.sustainability.army.mil/tools/docs_leeds/OASA(IE)%20sustainable%20design%20policy%20(27%20Apr%2007).pdf>.

Similarly, the Air Force specifically mentions mission in connection with CRM and sustainability. The stated CRM policy is that the "Air Force Cultural Resources Management Program . . . is designed to comply with applicable statutes and regulations, and meet those requirements in concert with the military mission."[44] The Air Force's sustainability policy also brings the concept of the branch's mission into play. The Air Force's goal is to "apply sustainable development concepts in the planning, design, construction, environmental management, operations, maintenance, and disposal of facilities and infrastructure projects, consistent with budget and mission requirements."[45] The policy's elaborations of this statement make it clear that the Air Force believes that management of its facilities should be consistent with keeping the environmental impact of buildings to a minimum while creating a built environment that is healthy, productive, and livable.

The Marine Corps policy on sustainability links the idea of environmental preservation with cultural resources preservation, and states that the two are compatible goals: "sustainability has often been an integral part of the composition of both tangible and intangible cultural resources. Ecological sustainability and preservation of cultural resources are complementary. In large part, the historic events and cultural values that are commemorated were shaped by humankind's response to the environment."[46] Furthermore, the Marine Corps policy states that "When a cultural resource achieves sufficient importance that it is deemed historically significant, it becomes a nonrenewable resource worthy of consideration for sustainable conservation. Management, preservation, and maintenance of cultural resources should be directed to that end." In other words, cultural resources within the Marine Corps should not only be preserved and curated for their own sake as important historic resources, they should be preserved and maintained using principles of sustainability. Of the service branches, the Marine Corps provides the most explicit pairing of CRM with sustainability as complementary ends that need to be pursued in tandem.

The Marine Corp's CRM statement, meanwhile, is similar to that of the other service branches in that it prominently mentions mission in connection with CRM, while reiterating the importance of incorporating sustainability into CRM: "Through the integration of its cultural resources management policies and procedures with Marine Corps mission, the Marine Corps

---

[44] Draft AF Pamphlet 32-XXXX, Guidelines for Managing Cultural Resources, accessed at: <www.afcee.af.mil/shared/media/document/AFD-070828-059.doc>.

[45] Air Force Sustainable Ops Policy Statement, accessed at: <www.homestead.afrc.af.mil/library/factsheets/factseet_print.asp?fsID=3457&page=1>.

[46] Accessed at: <http://www.marines.mil/unit/logistics/Documents/LFL/LFL-1/CulturalResources/Policy/Marine%20Corps%20Order%205090.2A,%20Chap_8_Change_2_Final.pdf>, p. 8-28-29.

will provide stewardship of cultural resources in a sustainable manner that supports the mission and promotes the quality of life for stakeholders."[47] Again, it is somewhat unclear as to whether supporting the "mission" of the service branch will always be compatible with "providing stewardship of cultural resources," and whether this can always be done in a "sustainable manner."

The Navy's CRM policy statement is similar to that offered by the Air Force, and goes further in stating that "Protection of . . . components of the nation's heritage is an essential part of the defense mission." These components include "historic buildings, structures, districts, sites, ships, aircraft and other cultural resources."[48] The Navy's policy on historic preservation is the most explicit in implying that protection of historic heritage is actually a part of the defense mission of the service branch, rather than simply a secondary mission of the service branch. Meanwhile, the Navy's statement on sustainability makes clear that Navy policy is to "reduce the life-cycle cost of shore facilities by incorporating sustainable development concepts and principles in the planning, design, construction, operation and maintenance, sustainment, restoration and modernization of all facilities and infrastructure projects to the fullest extent possible, *consistent with mission,* budget, and client requirements." The Navy policy mentions sustainability in relation to the mission and to life-cycle cost, relating the notion of "sustainability" to economics, as does the Army's sustainability policy. Making sustainability measures contingent on life-cycle costs implies that sustainability may take a lower priority in the long-term management of existing buildings than cost efficiency in building operation and management. The Navy's policy also incorporates the USGBC's LEED Green Building Rating System "as a tool" to apply sustainable principles to buildings. Whether actual LEED certification is required is not stated.

Executive Orders 13423 and 13514, along with the EPAct and EISA 2007, all dictate making Federal buildings more energy efficient, with the EPAct and EISA 2007 both mandating 30% increases in energy efficiency for Federal buildings.[49] Undoubtedly, successfully instituting such measures in historic Federal buildings without also compromising their historic character-

[47] Accessed at: <http://www.marines.mil/unit/logistics/Documents/LFL/LFL-1/CulturalResources/Policy/Marine% 20Corps%20Order%205090.2A,%20Chap_8_Change_2_Final.pdf>, p. 8-16.

[48] Accessed at: <http://doni.daps.dla.mil/directives/04000%20logistical%20support%20and%20services/04-00%20general%20logistical%20support/4000.35a.pdf>.

[49] Executive orders can be accessed, respectively, at: <http://www.ntis.gov/pdf/EO13423.pdf>; <http://www.ntis.gov/pdf/EO13514.pdf>; <http://ncseonline.org/NLE/CRSreports/06Apr/RL33302.pdf>; and <http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf>.

defining features will depend on local circumstances. Some of EISA's stipulations for energy efficiency mandates include exploration of LED technology, which is more energy efficient than fluorescent and incandescent lighting, and which can likely be retrofitted in historic buildings with minimum alteration of character-defining features. So, possibly, can more energy efficient HVAC systems, which are also mandated by EISA. Renovations to buildings being leased by the Federal government to bring them into Energy Star compliance either before or after occupation has begun is also another EISA stipulation that may impact features of historic buildings. Sections of EISA that mandate the reduction of fossil fuel use in new and existing buildings undergoing major renovation by 55% by 2010 and 100% by 2030 will obviously also have an impact on buildings in the Federal inventory that undergo major renovation for adaptive reuse, including historic buildings.

The Federal Leadership in High Performance and Sustainable Buildings MOU contains sections that are more clearly related to new construction than to historic buildings, most notably Section III, regarding efficient water use, and Section V, regarding reduction of environmental impact of materials.[50] Sections I, integrated design principles, II, optimizing energy performance, and IV, indoor environmental quality (IEQ), while applying directly to new construction, also apply to historic buildings as they were originally designed and configured. The MOU is discussed in detail in Chapter 4.

OMB Circular A-11 is the document that governs the investment of public resources in capital assets such as buildings.[51] It mentions sustainable design principles in relation to new and "replacement buildings" (the definition of which is not given in the text of the circular), and also refers to the EPAct, Section 109, which mandates that energy consumption in Federal existing buildings be increased by 30% over existing "industry or international standards," provided such standards are "life-cycle cost-effective." The implication of the final caveat is that achieving sustainability standards needs to be done within levels consistent with economic feasibility for the long-term management of the building as a capital asset.

As for overarching Federal regulations governing historic preservation management, the NHPA of 1966 gives high priority to the preservation of historic buildings as an irreplaceable part of "community life" and "historic heritage." Of particular interest in the NHPA is the following statement: "The preservation of this irreplaceable heritage is in the public interest so that its

[50] Accessed at: <http://www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=4713&destination=ShowItem>.

[51] Accessed at: <http://www.whitehouse.gov/omb/assets/a11_current_year/a_11_2009.pdf>.

vital legacy of cultural, educational, aesthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Americans."[52] Preservation of historic properties, in other words, can have economic benefits and energy benefits, tying the other "intangible" benefits to both cost efficiency and sustainability benefits in reusing an existing building. While "embodied energy" is a concept that preservationists have embraced as another weapon in the battle to save existing historic buildings, it is sometimes overlooked in both the private and public sectors as part of the equation for both economic and environmental benefits.

The Secretary of the Interior's Standards for the Treatment of Historic Properties may in specific instances have implications for sustainability upgrades for Federal buildings.[53] As described above, the four approaches—Preservation, Rehabilitation, Restoration, and Reconstruction—are generally regarded in the preservation community as being a hierarchy, with Preservation being most preferable and Reconstruction being the least. Sustainability measures could have a negative impact on historic character-defining features of a building, e.g., historic windows, when they have been targeted for replacement by more energy-efficient, "low E" windows. Reconciling such a window replacement with preserving the feature may be difficult, if not impossible; this is another instance in which a DoD cultural resource manager would need to work with installation project managers who are intent upon making buildings more sustainable, possibly in tandem with the SHPO or the ACHP.

Finally, Executive Order 13287, like many DoD policies on sustainability and preservation, also specifically mentions that historic preservation should be actively pursued by the Federal government so long as it is "consistent with executive branch department and agency missions."[54] As with the policy statements discussed above that also mention mission, the same caveats may be said to apply in the Federal government's pursuit of mission in relation to preservation—that is, that preservation goals and agency missions may at times be in conflict. The Order does, however, also mention that the "Federal Government shall recognize and manage the historic properties in its ownership as assets that can support department and agency missions." The acknowledgement that preservation of historic buildings and sites can be *compatible* with agency missions would not necessarily appear to be in concord with the statement that they should be pursued so long as they are *consistent* with Federal agency

[52] Accessed at: <http://www.achp.gov/docs/nhpa%202008-final.pdf>.
[53] Accessed at: <www.nps.gov/history/hps/tps/standguide/>.
[54] Accessed at: <http://www.gsa.gov/Portal/gsa/ep/contentView.do?P=PLAE&contentType=GSA_BASIC&contentId=16910>.

missions. At the same time, it does appear to reinforce the notion that Federal agencies should seek out opportunities to preserve historic buildings in order to *support* their missions. For example, a DoD department can adaptively re-use a building, or continue to use it in its original purpose, to support its mission—e.g., it can preserve an administrative building that continues to serve its purpose, in close to original condition, and that is energy efficient in its design.

It would appear that Federal laws and policies contain numerous potential conflicts among sustainability, historic preservation, and Federal agency missions. Some ambiguity in policy statements, especially regarding DoD missions (for example in relation to preservation and sustainability), implies that at times, if it is not cost-effective, or does not support the mission of an installation or a DoD branch, a given cultural resource may fall victim to other priorities which may be viewed as having precedence over preservation. By the same token, sustainability may be viewed as a lesser priority in instances where it comes in conflict with mission. The challenge will be to reconcile the various laws, regulations, and policy statements so that primary missions are served while also supporting Federal laws and policies that emphasize and mandate that historic preservation and sustainability are vital to and inseparable from national interests. The identification and analysis of sustainable historic building features and tips for successful rehabilitations in the following chapters of this report serve to address this challenge.

3.0 THE ROLE OF TECHNOLOGY AND BUILDINGS AS SYSTEMS

I believe that architecture has little or nothing to do with the invention of interesting forms or with personal inclinations. True architecture is always objective and is the expression of the inner structure of our time, from which it stems.

Mies van der Rohe

The broad inventory of historic buildings under DoD ownership overlaps with a host of technological innovations that have resulted in advancements in building design and construction principles, and improvements in IEQ. An obvious example would be the day in 1882, when Thomas Edison switched on the power at his Pearl Street generating station and in doing so distributed electricity to fifty-nine new-found consumers in lower Manhattan. From that day forward, electricity quickly became a part of the American way of life and soon significantly affected architecture and the operation of buildings. Twenty years later, the development of the first residential cooling system by Willis Carrier set the stage for the first air conditioned skyscraper, the Milam Building in San Antonio, Texas, built in 1928 using a system designed by Carrier. The impact of this innovation on the building's design and configuration was evident in the building's two 375-ton refrigeration units, a cooling tower at the rear of the building that drew water from the river, and the eleven fan/heat units that kept temperatures below 80 degrees F. in the summer and above 70 degrees in the winter. It also featured "air tight" windows and cloth shades to control solar gain and motor-driven dampers in the main duct lines on each floor that allowed the building engineer to manually balance cool and warm air.[55]

As the twentieth century moved into its fourth decade, the American architectural movement began to move away from the classic revival styles (Colonial, Greek Revival, etc.) and instead began to embrace new design styles, such as Art Deco and Moderne, which reflected the streamlined styling of the Modern Age. At the end of this period, architects in Europe and to a lesser extent in the United States, began to experiment with what became known as the International Style, which prized volume over mass, embraced new structural technologies of

[55] See <www.milambuilding.com>.

steel and concrete, and used the rhythmic organization of these technologies to allow the exterior walls to be non-structural and "stretched like a membrane around an open box."[56]

Before these technological advances and the development of modern architecture, it was necessary for buildings to respond to the environment in order to provide thermal comfort, as well as shelter. The architectural design and features worked together to provide ventilation, lighting, and the best methods possible to take advantage of the environment for heating and cooling. The features worked together to provide thermal comfort. With the introduction of air conditioning and new structural materials, architects were no longer constrained by local environmental conditions since they could create and control their own environments. These mechanical, electrical, and structural advances allowed for buildings to be constructed in any configuration and orientation, as long as the building was sealed from the exterior environment. Even though they were sealed, the building could be subject to fluctuations in temperature, as was the Milam Building; however, fuel was readily available and inexpensive, so with the flip of a switch adjustments could be made easily and cheaply.

These now-historic buildings are each representative of their period of construction and as a result exhibit elements of their "technological time"—either pre-HVAC systems or post-HVAC. In the world of historic preservation, the elements of systems designed for thermal comfort in pre-HVAC buildings are more often than not character-defining features, which are significant components of the building's historic fabric, and thus are to be preserved. The major processes that historic builders incorporated into their building systems to provide for maximum thermal comfort are defined and discussed in the following pages.

3.1 VENTILATION

Natural ventilation—comprised of two concepts: wind and buoyancy—allows fresh air to flow into buildings. Wind ventilation is achieved through pressure, in that wind causes a positive pressure on the windward side and a negative pressure is developed on the leeward side. To equalize the pressure, air will enter a windward opening and be exhausted from a leeward opening. During the summer months, before mechanical cooling systems were invented, fenestration and wind were used to provide fresh air. This happened when cold dense air pushed against hot air, thus creating a buoyancy effect. The degree of movement created by

[56] See William H. Jordy, *American Buildings and Their Architects* (New York: Anchor Press 1976).

that effect was based on the building's height; the taller the building or chimney the greater the draw. To a certain degree, masonry chimneys contributed to fresh air, as the heated air would be drawn upwards through the "stack effect." During the winter, the indoor environment is warmer than the exterior so the stack effect worked to provide adequate ventilation to exhaust stale air. The heat and humidity given off by the building occupants would cause the air to rise and escape from openings in the roof, which allowed fresh air to enter through lower openings (in pre-HVAC buildings, the lower cold air most likely came through the flooring and gaps in fenestration).

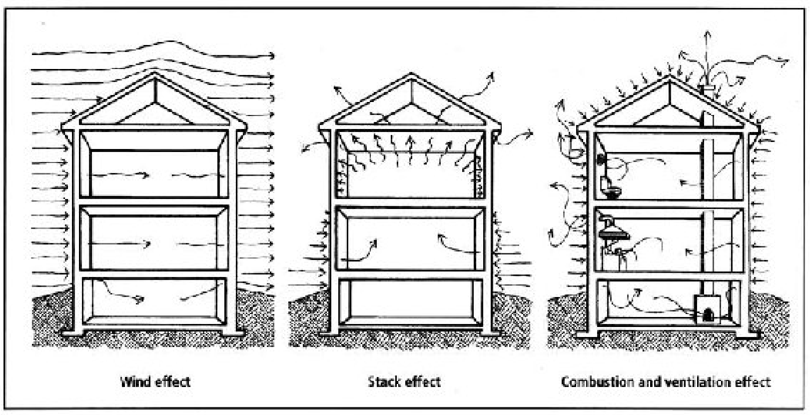


Figure 1: Natural ventilation effects

Ventilation of a building is directly affected by climate. Building ventilation in a hot, dry climate with large diurnal temperature changes will react differently than in a warm, humid environment with little diurnal variation. A building with masonry mass in a hot, dry climate should be ventilated at night and then closed in the morning to keep out the hot daytime air. Occupants are then cooled by the radiant exchange between the dense mass created by the walls and floor. For a building in a warm, humid environment, it is important to use cross-ventilation to maintain indoor temperatures as close as possible to outdoor temperatures. If the building is closed up, then the interior temperature will rise.

Historic builders incorporated ventilation into building systems through several methods:

- Siting the long elevation of the building perpendicular to the summer winds
- Designing a narrow floor plan
- Installing operable windows
- Creating adequate internal airflow through the use of open spaces, door transoms, etc.
- Orienting windows across the room in an offset pattern to maximize the mixing of air within the room

- Building open staircases to provide a "stack effect" ventilation
- Constructing ridge vents along the roof
- Providing attic ventilation

Since the ventilation process operated as a system, any alteration to an element of the system would result in less than optimal efficiency—for example replacing operable windows with windows that do not open inhibits ventilation and impedes the proper functioning of the stack effect.

3.2 CONDUCTION, CONVECTION AND RADIATION

Many historic buildings incorporated passive solar components; however, most would have a "tempering" effect rather than the full passive solar impact as we know it today. By utilizing passive solar principles, however unwittingly, the heat gain would have assisted in providing thermal comfort, but would not have been the sole method of heating the building. Passive solar energy works through heat transfer, which is conveyed by three processes: (1) conduction, (2) radiation, and (3) convection.

Conductivity is the rate at which energy is transferred within a material or between two materials. Radiant heat moves through the air from warmer materials to cooler materials without contact between the materials. Radiant heat is the most comfortable type of heat in buildings. Convection is the transfer of heat from the surface of a material by a moving liquid, which in the case of buildings, means air. Conduction is involved in the original heat transfer from a wall material, but convection transfers the heat to the air and then the warm air rises and the cool air sinks. This continual air movement works in both directions such that when warm air comes into contact with a cold surface it will become heavy and sink, which causes a downdraft (resulting in uncomfortable IEQ). If heat alone (i.e., no ventilation) is the cause of the movement it is called natural convection.

In a passive solar heating system, solar rays strike a wall, heat forms on the surface and is conducted within the wall material. The heat then moves through the wall and when it reaches the interior surface it is radiated to the interior space. As that heat is released it begins the process of convection by warming the air and causing it to rise. This process continually heats the air and room until all the heat has moved through the wall.

Modern passive solar buildings are designed with specific orientations to take advantage of the solar gain based on latitude, an exact wall thickness and specific materials to ensure the heat will reach the interior at the optimal hours, and shading devices based on the sun angles to maximize gain in the winter and minimize gain in the summer. Designing and constructing solar buildings to maximize the advantages requires engineering and environmental analysis. It is often the case that passive solar heating systems require the addition of mechanical systems to control air flow and thus ensure that they work properly.

Although historically, architects and builders would have been aware of the sun and other environmental factors as a result of pure common sense, they would not have had the technological advantages employed by modern passive solar designers to design the type of sophisticated systems we see today. Therefore, the pre-mechanical historic buildings (those dating prior to the advent of mechanical heating/cooling systems) used a tempering approach. Today tempering can reduce heating requirements up to 25%, while a fully designed solar building can reduce them up to 75%. While early architects and builders may not have had the advantage of modern solar energy innovations, they did use the environment to their advantage.

Some of the ways that solar energy would have been incorporated into historic buildings include:

- The use of thermally massive construction materials
- Building orientation to take advantage of or reduce solar gain
- Shading devices
- Ventilation design that would equally distribute heat gain

3.3 DAYLIGHTING

Ventilation and heating work together to provide thermal comfort for the occupants of a building. In addition, the architecturally significant feature of tall, wide windows brought a great deal of natural light to the interior—a concept know today as "daylighting," which is used as a design element to minimize the use of electrical lights and thus reduce energy consumption.

Today when designers address daylighting, they work to carefully balance heat gain and loss, control glare, and manage variations of daylight availability. This can include shading devices and the choice of interior finishes. We now view daylighting as a way to reduce energy costs and enhance occupant productivity, but historically it was the primary device for lighting the interior of buildings and then later, as architecture moved to the self-contained box, glazed fenestration became less of a lighting factor than an architectural statement. Light and glazing go hand in hand, but as buildings became more self-contained and took advantage of electrical lighting, there was generally less of a need to rely on or use the natural light.

There are many aspects to daylighting and all are meant to provide quality, natural light to the interior of a building. It is important to filter direct light and "bounce" it to the interior of a building. Manipulating the contrast in brightness levels has been shown to reduce tiredness and increase attention spans of building inhabitants. Light can be filtered by planting vegetation, adding overhangs and using porches to provide shading or installing devices such as louvers or window treatments. Light can be bounced to the interior through architectural features such as light shelves, fenestration high in an interior space or sloped ceilings. As with solar energy, to take the best advantage of daylighting it is important to understand the building orientation; some orientations can cause too much light and others not enough.

Daylighting elements often found in historic building include:

- Tall, wide windows
- Narrow floor plans
- Contrasts in brightness levels
- Sloped ceilings
- Windows located high in a wall or roof
- Vegetation, overhangs, porches, louvers and curtains
- Building orientation that enhances the amount and quality of light

3.4 SUMMARY

Ventilation, heating, and daylighting are all aspects often found in historic building design and act together to make the building more comfortable for the user. Prior to the advent of HVAC systems and the modern architectural styles that emerged to accompany them, buildings were designed as systems that would function to provide the best interior environment possible with the known technologies and expertise of the day. As such, these buildings possess integrated designs that can lose heating, cooling, and comfort features if the design is significantly altered. For example, if the roof vents are removed or closed off, exhaust air cannot leave the building through the stack effect, and the natural heating or cooling methods will be ineffective. Often alterations have been made to historic buildings that ruin the original functional design and then the building is blamed for being inefficient. It is important to understand how the building was originally meant to function prior to making alterations to ensure the best results.

Even though pre-mechanical historic buildings may have been designed and constructed to respond to local environmental variables, that still does not mean that historic buildings meet the modern standards of sustainability; and yet it is by these standards that their energy conservation and sustainability performances are judged. For example, before mechanical cooling, buildings were orientated primarily to take advantage of ventilation and daylighting with open windows, while with the advent of mechanical cooling, which necessitated closed windows, it became standard to orient buildings such that the solar load was minimized. A second example is wall construction: while there may be an historic masonry-walled building that can provide better thermal massing than a wood frame wall, the "greener" masonry wall may not be the correct width or composition to best take advantage of solar gain, and thus does not meet the *contemporary* standards for a green building. For this reason we suggest that there are shades of green, which take into account an historic building's features that are already green, but which may not be "green enough" to meet modern standards.

4.0 MODERN SUSTAINABILITY CONCEPTS AND HISTORIC BUILDINGS: THE FEDERAL MOU

One way to evaluate the "greenness" of an historic building is to consider its relationship to current guiding principles of sustainable design and building. This is not to impose current standards onto the past, or to assume that historic builders thought about sustainable design in the same ways we currently do, but rather to identify those elements of historic buildings that might be capitalized on when planning rehabilitation projects. This chapter outlines the guiding principles of the Federal Leadership in High Performance and Sustainable Buildings MOU, and assesses whether or not and how each MOU principle applies to historic buildings.

4.1 THE FEDERAL MOU

The Federal Leadership in High Performance and Sustainable Buildings MOU is a document that was crafted by the NIBS's WBDG in conjunction with, and for compliance by, Federal entities in managing their existing and future facilities. According to the WBDG, the historical setting of the signing of this MOU[57] was as follows:

> *On January 24-25, 2006, more than 150 Federal facility managers and decision makers came together at the first-ever "White House Summit on Federal Sustainable Buildings" to witness the signing of the "Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU)." The MOU was the flagship Federal effort to define guiding principles of green building and provide leadership in the design, construction, operation, and maintenance of high performance and sustainable buildings.*[58]

4.1.1 GUIDING PRINCIPLES OF THE MOU

The Guiding Principles are designed to help promote four overarching goals of the Federal government in management of its buildings and facilities. These are to:

---

[57] The entire document, including signatories, can be accessed at: www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=4713&destination=ShowItem>.

[58] Accessed at: <www.wbdg.org/references/sustainable_eo.php>.

-Reduce the total ownership cost of facilities
-Improve energy efficiency and water conservation
-Provide safe, healthy, and productive built environments
-Promote sustainable environmental stewardship[59]

The five guiding principles of the MOU are as follows:

I. Employ Integrated Design Principles

- **Integrated Design.** Use a collaborative, integrated planning and design process that:
  - Initiates and maintains an integrated project team in all stages of a project's planning and delivery.
  - Establishes performance goals for siting, energy, water, materials, and indoor environmental quality along with other comprehensive design goals and ensures incorporation of these goals throughout the design and lifecycle of the building.
  - Considers all stages of the building's lifecycle, including deconstruction.
- **Commissioning.** Employ total building commissioning practices tailored to the size and complexity of the building and its system components in order to verify performance of building components and systems and help ensure that design requirements are met. This should include a designated commissioning authority, inclusion of commissioning requirements in construction documents, a commissioning plan, verification of the installation and performance of systems to be commissioned, and a commissioning report.

II. Optimize Energy Performance

- **Energy Efficiency.** Establish a whole building performance target that takes into account the intended use, occupancy, operations, plug loads, other energy demands, and design to earn the Energy Star® targets for new construction and major renovation where applicable. For new construction, reduce the energy cost budget by 30% compared to the baseline building performance rating per the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., (ASHRAE) and the Illuminating Engineering Society of North America (IESNA) Standard 90.1-2004, Energy Standard for Buildings Except Low-Rise Residential. For major renovations, reduce the energy cost

[59] "Goals and Objectives of this MOU," accessed at: <www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=4713&destination=ShowItem>, p. 1.

budget by 20% below pre-renovations 2003 baseline based on DOE CBECS 2003 building energy database.

- **Measurement and Verification.** In accordance with DOE guidelines issued under section 103 of the EPAct, install building level utility meters in new major construction and renovation projects to track and continuously optimize performance. Compare actual performance data from the first year of operation with the energy design target. After one year of occupancy, measure all new major installations using the Energy Star® Benchmarking Tool for building and space types covered by Energy Star®. Enter data and lessons learned from sustainable buildings into the High Performance Buildings Database.[60]

III. Protect and Conserve Water

- **Indoor Water.** Employ strategies that in aggregate use a minimum of 20% less potable water than the indoor water use baseline calculated for the building, after meeting the Energy Policy Act of 1992 fixture performance requirements.

- **Outdoor Water.** Use water efficient landscape and irrigation strategies, including water reuse and recycling, to reduce outdoor potable water consumption by a minimum of 50% over that consumed by conventional means (plant species and plant densities). Employ design and construction strategies that reduce storm water runoff and polluted site water runoff.

IV. Enhance Indoor Environmental Quality

- **Ventilation and Thermal Comfort.** Meet the current ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy, including continuous humidity control within established ranges per climate zone, and ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality.

- **Moisture Control.** Establish and implement a moisture control strategy for controlling moisture flows and condensation to prevent building damage and mold contamination.

[60] In the online document at: <www.fedcenter.gov/_kd/Items/actions.cfm?action= Show&item_id=4713&destination=ShowItem>, there is a link at this location in the text that leads to the High Performance Buildings Database. The link is <www.eere.energy.gov/femp/highperformance>.

- **Daylighting.** Achieve a minimum daylight factor of 2% (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks. Provide automatic dimming controls or accessible manual lighting controls, and appropriate glare control.
- **Low-Emitting Materials.** Specify materials and products with low pollutant emissions, including adhesives, sealants, paints, carpet systems, and furnishings.
- **Protect Indoor Air Quality during Construction.** Follow the recommended approach of the Sheet Metal and Air Conditioning Contractor's National Association Indoor Air Quality Guidelines for Occupied Buildings under Construction, 1995. After construction and prior to occupancy, conduct a minimum 72-hour flush-out with maximum outdoor air consistent with achieving relative humidity no greater than 60%. After occupancy, continue flush-out as necessary to minimize exposure to contaminants from new building materials.

V. Reduce Environmental Impact of Materials

- **Recycled Content.** For Environmental Protection Agency (EPA)-designated materials, use products meeting or exceeding EPA's recycled content recommendations. For other products, use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project.
- **Biobased Content.** For U.S. Department of Agriculture (USDA)-designated materials, use products meeting or exceeding USDA's biobased content recommendations. For other materials, use biobased materials made from rapidly renewable resources and certified sustainable wood products.
- **Construction Waste.** During a project's planning stage, identify local recycling and salvage operations that could process site related waste. Program the design to recycle or salvage at least 50% construction, demolition and land clearing waste, excluding soil, where markets or onsite recycling opportunities exist.
- **Ozone Depleting Compounds.** Eliminate the use of ozone depleting compounds during and after construction where alternative environmentally preferable products are available, consistent with either the Montreal Protocol and Title VI of the Clean Air Act Amendments of 1990, or equivalent overall air quality benefits that take into account life cycle impacts.

4.1.2 HOW THE GUIDING PRINCIPLES APPLY TO HISTORIC BUILDINGS

Some of the principles listed among the Guiding Principles are more clearly intended for new buildings being designed and constructed by and for Federal government agencies, including DoD Service branches. These principles are: III, "Protect and Conserve Water," and V, "Reduce Environmental Impact of Materials." Principles I, II, and IV have more immediate applications to historic buildings as they were originally conceived and constructed than Principles III and V.

4.1.2.1 PRINCIPLES THAT APPLY TO HISTORIC BUILDINGS

Principle I, "Employ Integrated Design Principles," ties into historic building practices that have been observed and documented by scholars on the subject. The use of "integrated" building practices also has implications for both **Principle II, "Optimize Energy Efficiency,"** and **Principle IV, "Enhance Indoor Environmental Quality."**

Historic builders of the era before sophisticated HVAC systems came into being and became widespread in the building industry likely thought of their buildings as passive systems that could aid in the process of warming, cooling, and ventilating building interiors for the sake of thermal comfort. Historic builders therefore had in mind both the comfort of occupants (which is related to enhancing IEQ) and saving on the amount of fuel burned to keep a building warm during winter months (which is related to optimizing energy efficiency). While historic builders did not necessarily abide by a modern concept of a "collaborative, integrated planning and design process," they were clearly thinking of factors that are alluded to by these principles, such as achieving energy efficiency and thermal comfort for building occupants by considering "siting, energy, water, materials, and indoor environmental quality." It should be noted that for water, builders were mainly concerned with finding a clean, available water source, rather than in conserving it as an exhaustible resource.

IEQ is probably the main consideration that governed many historic builders' intentions in constructing buildings as passive. Before the age of the International style building and the "machine ethic" that led to buildings being designed as closed systems that were heated, cooled, and ventilated by modern mechanical HVAC systems, many builders considered such factors as the siting and orientation of the building. For example, a building could be sited along an east-west axis to maximize the ventilation potential of orienting the long side of the building to prevailing winds; to minimize the thermal effects of sunlight particularly in the warm months, shading from vegetation or porches could be used. They did this to take advantage of the thermal and ventilation benefits that would accrue to building occupants and also to reduce the consumption of fuel (which could be costly or labor-intensive to produce) or perhaps the insulation needs in a building. Building siting could also help improve passive daylighting benefits, in conjunction with such other design considerations such as high and abundant windows and clerestories, light wells, and courtyards.

Historic builders also chose building materials to help improve the insulating qualities of the building envelope, in order to help improve the comfort of occupants and to reduce the cost of artificially heating and cooling buildings. Even before conservation of resources for the sake of preserving the environment became a conscious part of building strategy, builders were aware that certain building envelopes could provide better insulation or thermal qualities than others. During the millennia before there were artificial heating, cooling, and ventilation systems, builders who had the option often chose heavy masonry as a building material because it could offer better thermal conservation qualities than light-weight wood-frame construction (their choices on building materials, beyond the insulating properties, also took into consideration availability of materials, the purpose for which the building was intended, and of course, building costs). Builders used other techniques to ventilate buildings and draw out excessive heat during the warm summer months, such as peaked roofs with vents under the eaves to pull in outdoor air, and louvered vents in gable ends and dormers to draw warm air from the lower floors and release it into the outdoors.[61]

Life-cycle considerations (under Principle I) for historic builders might have been most applicable in cases where they were building for durability and permanence—i.e., they were not necessarily thinking in terms of the deconstruction of a building as they were in terms of ensuring that it would stand for a long time, in which case they often constructed buildings that were sturdy and difficult to knock down (especially in the case of masonry buildings). They likely did not consider such factors as the disposability or recycling potential of their building materials, although especially in pre-industrial times they were less likely to use environmentally harmful building materials. (Exceptions include lead and asbestos, the latter of which had been used by the ancients but which began to be used in buildings in the late 19th century as a fire retardant.)

---

[61] On historic builders' and their knowledge of the insulating properties of various building materials, see, for example, the early work by Reyner Banahm, *The Archit4ecture of the well-Tempered Environment* (Chicago: University of Chicago Press, 1969).

Modern renovations and rehabilitations of historic buildings that use passive techniques for thermal comfort should take the strategies that have been included in many older buildings and reincorporate them into the building system, so that the building operates the way it was originally intended to, and enhances whatever modern sustainability measures are incorporated into the rehabilitated facility. Historic builders thought of their creations as systems; the systemic advantages that apply to historic building features need to be reincorporated into the buildings for their continued effective, sustainable use.

4.1.2.2 PRINCIPLES THAT TYPICALLY DO NOT APPLY TO HISTORIC BUILDINGS.

Principle III, "Protect and Conserve Water," applies mainly to newer buildings because historic buildings, with their built-in plumbing infrastructure and their existing landscaping irrigation practices, were not designed with water efficiency practices and storm water mitigation practices in mind. Certainly, features such as storm gutters, rain barrels, and splash blocks were applied to historic buildings at the time of their original design and/or construction, but these measures were not specifically designed to reduce water runoff or assist in protecting and conserving water, or to guard against harmful effluents reaching riparian systems, ground water, etc. Rather, their main purpose was to carry water away from the building and the site in order to prevent site soil erosion and water damage to building components. Larger eco-system concerns were not part of the equation during an era preceding the growth of environmental consciousness. The same applied to indoor water efficiency: the primary water efficiency that designers and building occupants cared about, by and large, was that the water was delivered via the plumbing to the building's interior, and waste was carried away from it by the plumbing. In general, interior water conservation did not become a major concern of building designers until the latter half of the twentieth century, especially beginning in the late 1960s, when an environmental ethos based on resource conservation and reduction of waste began to develop.[62]

If historic buildings are adaptively used or reused, current and future designers and builders will likely have an entirely different attitude toward indoor and outdoor water conservation than did the original builders. Fortunately, old buildings can be and have been successfully

---

[62] In arid regions, for example in the U.S. Southwest, historic builders may have taken more care in their designs to build in water conservation measures. Certainly, the commons from which builders gathered timber, water, and other resources were managed with care to conserve those resources to ensure their continued availability. While modern building ethics of sustainability take into consideration the protection of resources globally, historic builders' were on local and regional levels.

retrofitted to use water conservation measures. In the DoD, historic buildings such as the Pentagon, which is a National Historic Landmark, have had both their interior plumbing and their landscape irrigation systems revamped for water efficiency, with no affect to character-defining features.

Principle V, "Reduce Environmental Impact of Materials," is another principle that does not, for the most part, apply to historic buildings as they were originally designed and built, except perhaps in the sense that sometimes builders took care to select materials that were readily available for use (i.e., they chose materials based not on their renewability or to reduce their impact upon the planet, but on their availability, utility, and cost efficiency). For example, if timber resources, and the labor to harvest and supply them, were available at the right price, they were purchased and used, so long as they made a good and cost-effective building material. The environmental impacts of clear-cutting of timber, transporting the lumber to a building site, and other considerations that we now think of as having an environmental cost, were most likely not part of the builder's calculations. Undoubtedly, the economic advantages of using nearby timber sources would have been part of historic builders' cost analysis, as would the eventual exhaustion of nearby timber resources, which would have driven up the cost of lumber.

If an historic building in the DoD inventory is proposed for reuse, then considerations for reducing the environmental impact of materials can and should be considered in any rehabilitation or remodeling of the existing facility. Using recycled and bio-based content, reducing and recycling construction waste wherever possible, and eliminating the use of ozone-depleting compounds, will all become part of the building rehabilitation equation.

4.2 SUMMARY

The fact that those who designed and constructed historic buildings did not think in terms of "green," "sustainable," or "energy efficient" building in the same ways that we currently do means that although we should not judge historic buildings entirely by modern standards, we can apply current principles that guide overall building sustainability to historic buildings. In so doing, we can identify those elements of historic buildings that contribute to energy efficiency and overall sustainability and properly identify where we can make improvements. Using the MOU principles to assess the ways in which historic buildings are already green should be part of any thorough and holistic analysis that precedes the rehabilitation of an historic building.

5.0 SHADES OF GREEN: SUSTAINABLE FEATURES OF HISTORIC BUILDINGS

Often what makes an element of an historic building "green" is how that element interacts with other parts of the building system. This chapter first discusses the environmental and human variables and basic building components that play into the sustainability of historic buildings; each is examined in relationship to how it can contribute to the sustainability of a building in the categories of integrated design principles, energy performance, or IEQ. Next, character-defining features are identified for each of the architectural styles most commonly found in DoD historic buildings, and those character-defining features that can most commonly function as sustainable elements are identified and discussed. Throughout the chapter, tips for successful sustainability rehabilitation are provided where applicable.

Most of the features discussed in this chapter are "green" as they relate to IEQ, which focuses on developing interiors that are healthy, comfortable and productive for the building occupants. Under the Federal MOU, the categories within IEQ include: ventilation and thermal comfort, moisture control, daylighting, and low-emitting (low-e) materials. In most cases, moisture control and low-e materials are primarily related to retrofits. Low-e relates to new products that will be used in the building, and while moisture control may have been designed as part of the original building, it should be reassessed as part of a rehabilitation to make sure the historic systems are working and that new alterations will not adversely impact how moisture moves through the historic fabric.

In historic properties, original features that contribute to IEQ typically affect ventilation, thermal comfort, and daylighting, and include, for example:

- Building Shape: Narrow buildings provide more opportunity for daylighting
- Roofs/Vents/Walls/Foundations/Shape: Work together to provide ventilation and thermal comfort
- Fenestration/Windows: Provide natural light sources and views
- Window Coverings/Eaves/Porches/Vegetation: These can aid in tempering daylighting, as well as ventilation and thermal comfort.

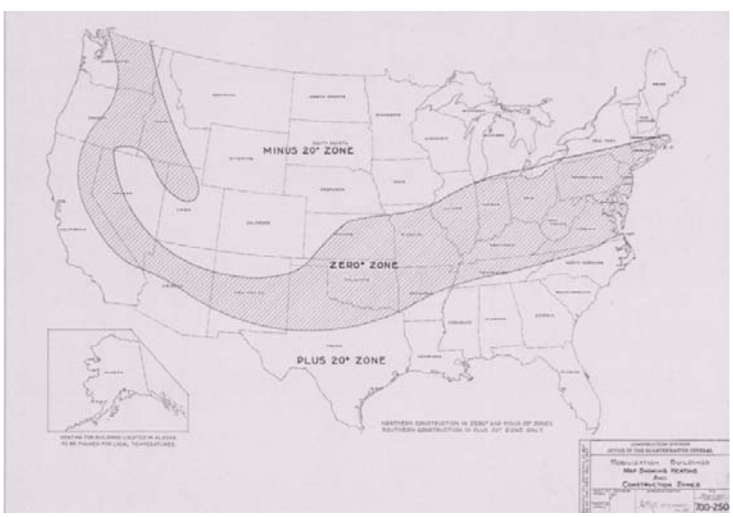
It is important in any green rehabilitation project to understand how a building currently functions, how the historic building system was meant to function, and to compare that with how the DoD would like that building to function. Likewise, although the following chapter discusses potentially "green" building elements separately, it is essential to remember that the true "shade of green" of an historic building is dependent upon the systemic interplay between building elements—a more specific examination of this interplay is presented in the case study of Building 56 at Fort MacPherson, discussed in Chapter 6.

5.1 ENVIRONMENTAL AND HUMAN VARIABLES

Beyond the building itself, there are environmental and human variables that can dramatically affect the sustainability of an historic building.

Climate: Clearly, climate is a major contributing factor to how a building will consume energy and provide comfort. Even as early as 1863, historic army standard plans recognized this fact and attempted to mitigate the challenges posed by various climates by creating climate-specific north and south versions of the same plans. Army regulations dictated:

> "225 square feet per man for posts located north of 38 degrees North latitude and 256 square feet per man for posts located south of that line." The height of the rooms was to be 10 feet, giving a man north of 38 degrees north latitude 375 cubic feet of space and man south of 38 degrees north latitude 426 cubic feet.[63]



Smaller spaces in colder northern climates were easier to keep warm, while larger spaces were more comfortable in warmer southern climates as they allowed for increased ventilation and cooling.

Figure 2: 1932 Map of Construction Division Office of the Quartermaster General, indicating northern and southern construction zones

[63] Army regulations quoted in U.S. Army Corps of Engineers, Seattle District, "Context Study of the United States Quartermaster General Standardized Plans, 1866–1942" (U.S. Army Environmental Center, Environmental Compliance Division, Aberdeen Proving Ground, MD., 1997), 41.

Climate, perhaps more than any other variable, can affect how "green" building elements are. For example, in a cold northern climate, using copious fenestration would have created ample opportunity for the release of heat through glass and would allow more opportunity for cold air to enter through window surrounds—i.e., an over-abundance of windows could have a negative impact on overall building sustainability. However, in temperate climates, abundant windows could provide more benefit than loss in the form of increased ventilation and daylight.

> *Rehabilitation Tip*: Conducting a thorough analysis of how building components and character-defining features served to mitigate the effects of local climate can suggest avenues for more cost-effective and preservation-sensitive rehabilitations, and may also suggest the restoration of character-defining features that originally served important sustainability functions in the building system.

Orientation: Historic buildings often used orientation to improve the indoor IEQ of a building. Proper orientation, which would vary depending on location, could enhance the quantity and availability of daylight, take advantage of solar gain, reduce solar gain, or improve ventilation. Historic builders and designers were aware of these potential advantages. As mentioned in the introduction, when designing the Fort Bliss layout in 1891, Quartermaster Captain George Ruhlen purposefully oriented the long axis of barracks buildings along a north-south axis, to take advantage of prevailing winds. He constructed a porch on the west elevation to mitigate heat gain.

> *Rehabilitation Tip*: Analyzing how the orientation affects the energy aspects of the building and whether it can be used to support natural ventilation, daylighting, and views from the interior will help provide guidance in optimizing the green aspects of the rehabilitation.

Use: Historic buildings were most often designed for specific purposes. The original intended uses of buildings often played into their design to create spaces that were as comfortable and healthy as possible for the most commonly preformed activities in that building. For example, at Fort Bliss, Texas, as the original barracks buildings were designed in the 1890s, the sleeping quarters were purposefully narrowed from their original standard plan design, reducing the width and increasing the length of the areas in which soldiers would sleep in order to, as the Quartermaster's Office wrote, "give better ventilation for a hot climate." The latrines were also removed from the main building into structures of their own behind the sleeping quarters to eliminate "the necessity of rooms at the outer end of the dormitory where they exclude light and circulation of air to the main room."[64]

> *Rehabilitation Tip*: Few historic buildings continue to be used as originally intended. Adaptive reuse often necessitates altering some of the very elements of a building that were originally intended to provide for the comfort of those who occupied it. Sometimes these alterations, once they are recognized as hindrances to the original built-in sustainability of historic buildings, can be restored, but often the requirements of modern work and living make returning these altered elements impractical. Understanding how a building was originally used and how the space was configured to facilitate those original uses can help us to make better decisions about adaptive reuse and rehabilitation projects. Take again the example of the barracks at Fort Bliss. The building is no longer used as barracks, but rather as office space, which has caused the division of the open interior space to be closed off into separate office spaces. While these partitions do not affect the actual energy consumption of the building, they do affect ventilation and daylighting. Such partitions should be avoided; however, if partitions are required to provide appropriate office space, internal windows, transoms and other devices might be used to bring light to the interior. If partitions reduce ventilation, the new mechanical system would need to provide a method to ensure proper ventilation. When the use of a building is changed, it can affect daylighting, ventilation, and thermal comfort, and all should be analyzed to ensure they will work properly in the retrofit.

5.2 BASIC BUILDING COMPONENTS

In addition to the environmental and human variables discussed above, the sustainability of historic buildings is also influenced by the make-up of its basic components. There are several basic building components that are present in every building regardless of style or function: shape, foundation, walls, roof, and openings. Although each of these basic building components can take a plethora of forms, in general, all of the basic components can be broken down into several broad groups—some of which are generally more sustainable, while others

[64] Quotes reproduced in "A Survey History of Fort Bliss, 1890-1940," Historical and Natural Resources Report No. 5, Perry Jamieson (Cultural Resources Management Branch, Directorate of Environment, Fort Bliss, TX, 1993), p. 4.

can have either a greening effect or a negative sustainability impact depending on other building elements.

Shape: Although historic buildings were constructed in many different shapes, which were often determined by a combination of architectural style and use, these shapes can be grouped into two large categories: internally loaded and externally loaded buildings. Internally loaded buildings get most of their energy from within—they are lit, heated, and cooled primarily from internal sources such as furnaces and fireplaces or through the stack effect. Typically multi-storied and consisting of one central mass, perhaps a square or slightly irregular shape, internally loaded buildings may perform better than externally loaded structures in cooler climates. With fewer windows and less exposed to the climate, an internally loaded building could have sustainability benefits by keeping heat centrally located, and using body heat and the stack effect to keep the primary spaces warm.

Externally loaded or skin-loaded buildings are lit primarily by daylighting and might take such shapes as long and narrow rectangles or U-shapes. Their energy consumption is prescribed primarily by the influence of the climate on the building's envelope. By incorporating thermal mass building materials, such as brick or adobe, externally loaded buildings can possess good passive solar design. The shape of an historic building is intertwined with the construction materials, ventilation system, climate, etc. and it is the combination of these elements that helps to determine how sustainable externally or internally loaded historic buildings can be.

Walls: Materials for historic building wall construction generally fall into one of three categories: solid mass, wood frame, and aerated mass. Solid mass includes brick, stone, adobe, and concrete construction. Sustainability benefits of solid mass walls include their thermal insulation properties, which can increase thermal comfort and may also improve energy performance. Perhaps the greatest sustainability benefits of solid mass walls is that they typically possess large mass and weight and therefore have a high thermal inertia, which slows heat transmission from outside surfaces to the interior. This can be a sustainable property particularly in climates with diurnal temperature fluctuations and dramatic seasonal variation, for example the U.S. Southwest. In such climates, solid mass walls can absorb solar radiation all day and release it slowly at night. Historic buildings constructed with solid mass walls are generally slow to respond to external temperature changes, unlike modern buildings that use glass and lightweight materials, which are much faster to bring in heat and cold.

In general, wood frame construction is the least energy efficient. Wood frame construction provides almost no thermal mass and, unless it has been retrofitted, is typically poorly insulated. It was not until after 1910 that standard plans allowed for the option of brick or wood frame for permanent construction, thus most historic buildings that use wood frame date after 1910. Despite its drawbacks, in some climates wood frame construction can perform very well. For example, San Francisco's Presidio, located in a temperate climate, contains many historic structures constructed of lightweight wood frame, which combined with the abundant fenestration and narrow floor plans of the buildings perform adequately in terms of temperature control.

Aerated mass construction is most commonly realized through the use of hollow clay tile, which in the right climates can provide a number of green benefits. For example, at Eglin Air Force Base in Florida, the permanent structures built during World War II used terra cotta tiles because they best mitigated heat, humidity, pests, and hurricane winds.

To further improve the temperature control of historic buildings, exterior walls were often painted. In warm climates, light colors were used to reflect the hot summer sun, resulting in cooler interior living spaces, while in colder climates dark paint could help walls absorb heat and light.

Roofs: Historic buildings possess two basic roof shapes: pitched or flat. Many pitched roof historic buildings take advantage of the stack effect, and use ventilation to distribute heat gain. Attic spaces provide a collection spot for hot air, and when properly vented, release heat to the outside. Flat roofs should also provide ventilation, but in most cases probably do not provide historic buildings with any particularly green benefits.

Foundations and subterranean spaces: As is the case with all basic building components, the green aspects of foundations, cellars, basements, and crawlspaces in historic buildings is strongly related to the building system, climate, etc. In terms of energy performance, basements and crawlspaces can pose more challenges than they do sustainability benefits as there can be substantial heat loss through basements and crawl spaces. However, many historic buildings included these subterranean spaces as refuges from the hotter above-ground levels, providing cool places with more constant temperatures that were ideal for food or wine storage. The subterranean areas of historic buildings could also function as part of the building's ventilation system, pulling cool air from below through the stack effect, into the main area of the home. Although this phenomenon may have provided cooling benefits in some historic buildings, it also presents potential problems for health and IEQ as mold, soil gases, and dust are also pulled up into the building along with cool air.

Fenestration: The number and types of fenestration—windows and doors—an historic building possesses can be a crucial element in how green the building is. Recent audits conducted using thermal imaging techniques have shown that often more heat is lost around door openings than windows.[65] In those cases, the doors do not appear to be as well-sealed as the window units. As far as energy conservation is concerned, the more openings a building possesses, the less energy efficient it will be. However, in terms of IEQ, openings, particularly windows (the green features of which are discussed in detail below) are an essential means of providing natural ventilation and daylighting in historic buildings.

> *Rehabilitation Tip:* The roof, vents, wall, foundations (slab on grade, crawl space or basement) and the shape all affect the ventilation and thermal comfort of a building. The shape defines whether a building is internally or externally loaded, that is, whether it is heated primarily by the activities and occupants or by the outdoor environment. This is a critical factor in understanding how to add a new HVAC system to the structure. In addition, the roof, walls and foundation all contribute, as a system, to how air and moisture move through a building and whether ventilation and thermal comfort can be achieved effectively. It is important to analyze not only how the building is functioning today (which likely includes a number or retrofits since its original construction), but how it originally was intended to function. If original architectural features are missing, perhaps restoring them would add to or enhance the HVAC capabilities and effectiveness. Alterations can be made to the roof, walls and foundation to upgrade the energy efficiency; however, it is important to ask questions and use analysis to ensure that the addition of insulation will not reduce ventilation or cause moisture problems. In addition, it is necessary to understand whether the alterations can enhance the energy efficiency *and* maintain the historic character.

[65] Presentation video on thermal imaging, Air Force Cultural Resource Manager Workshop, May 11–13, 2010.

5.3 CHARACTER-DEFINING FEATURES

Historic buildings may also possess, or have originally possessed, architectural features that were driven by architectural style, intended use, or basic building components and which may, under certain circumstances, contribute to the sustainability of an historic building either through integrated design, energy performance, or IEQ.

5.3.1 IDENTIFYING CHARACTER-DEFINING FEATURES

It is essential to identify a historic building's character-defining, architectural or landscape features in order to consider them in a proposed green renovation project. These features are integral to a building or structure's historic and architectural significance and integrity. Character-defining features generally include the physical make-up of the building, structure, or landscape, such as the overall shape, design, materials, craftsmanship, decorative features, and aspects of site layout or landscape context. It is important when designing a project for a historic property that one identifies the building's character-defining features and considers how the project will affect them. When designing a sustainability project, it is also important to analyze the character-defining features and other historic aspects of the building with regard to their inherent "greenness" to determine whether they can support the sustainability goals.

There are thousands of standard plans used by the military and many military buildings were not constructed using standard plans. This study has compiled those American architectural styles that have most heavily impacted DoD buildings, grouped them, provided the character-defining features of each (

Table 1), and then called out those character-defining features that might be considered "green."[66]

[66] This is based on Le Corbusier's 'five elements' which defined a new architectural era. See Jordy, *American Buildings,* 1976.

Table 1: Typical style features that affect building performance

		Shape*		Massing				Wall Material				Fenestration				
	Architectural Style	Externally Loaded	Internally Loaded	Flat Roof	Pitched Roof	Eaves & Porches	Basements	Solid Masonry	Aerated Masonry	Steel Frame	Wood Frame	16-25%	26-50%	51-100%	Operable Windows	Non-Mechanical Vents
Group A	QUEEN ANNE	•			•	•	•	•			•		•		•	•
Group A	ITALIANATE	•		•	•	•	•	•			•		•		•	•
Group A	RICHARSONIAN ROMAN	•			•		•	•					•		•	•
Group A	PRAIRIE	•		•	•	•	•	•			•		•	•	•	•
Group A	BUNGALOW/CRAFTSMAN	•			•	•	•	•			•		•		•	•
Group A	CLASSICAL REVIVAL	•		•	•	•	•	•			•		•		•	•
Group A	MISSION REVIVAL	•		•	•	•	•		•		•		•		•	•
Group B	ART DECO/MODERNE		•	•			•	•	•				•		•	
Group B	INTERNATIONAL		•	•			•	•	•	•				•		
Group B	BRUTALISM		•	•			•	•				•	•			
Group B	FORMALISM		•	•			•	•		•				•		
Group B	POST MODERNISM		•		•	•	•			•	•		•			
C	MILITARY VERNACULAR	•		•	•	•		•	•		•		•		•	•
	*Externally loaded buildings are generally narrow and internally loaded are generally deeper, square buildings.															

Group A

1. The "Victorian Era" (late 19th century) was dominated architecturally by the Queen Anne, Italianate, and Richardsonian Romanesque styles. Except for the Queen Anne, which featured irregular shapes, these building styles were generally rectilinear in shape, constructed of brick or stone, and had multi-storied massing with pitched roofs. They were noted for their vertically aligned, multi-light, wood sash windows and their high degree of ornamentation on building facades and porches, which included detailed ornate bracketing, turned columns, sculptured stonework, and cast iron metalwork.

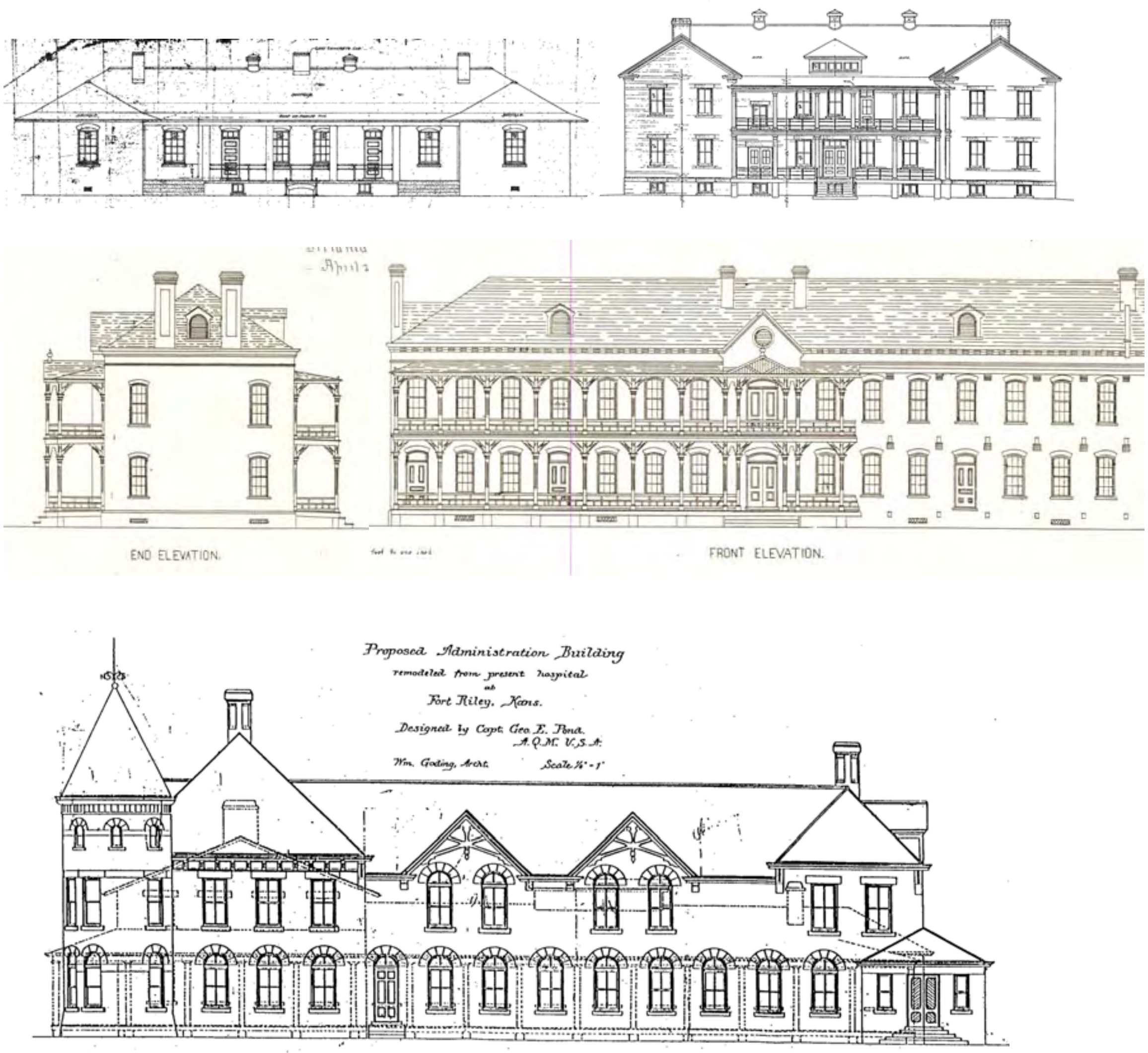


Figure 3: Examples of Group A "Victorian Era" historic architecture in the DoD

2. By the turn of the twentieth century, the more contemporary looking Prairie style and Bungalow/Craftsman style became popular, primarily for residential structures, while commercial buildings still commonly employed the Italianate style. The Prairie and Bungalow styles featured flat (Prairie style) or pitched roofs with long overhanging eaves with exposed rafter ends. Heavy ornamentation on the building's exteriors was lacking.

Figure 4: Examples of Group A "Prairie and Bungalow" interpretations in the DoD

3. In the 1920s, period revival architecture became popular based on classical styles such as Colonial, Georgian, Greek, and Beaux Arts, as well as the Spanish Mission Revival style. These styles were rectilinear in shape with flat (Mission Revival) and pitched roofs. Exterior ornamentation was generally simple and tended to copy classical features such as porticoes, columns (both free-standing and engaged), window and door triangular pediments, and in the case of Mission Revival, Spanish baroque entryways and ironwork.

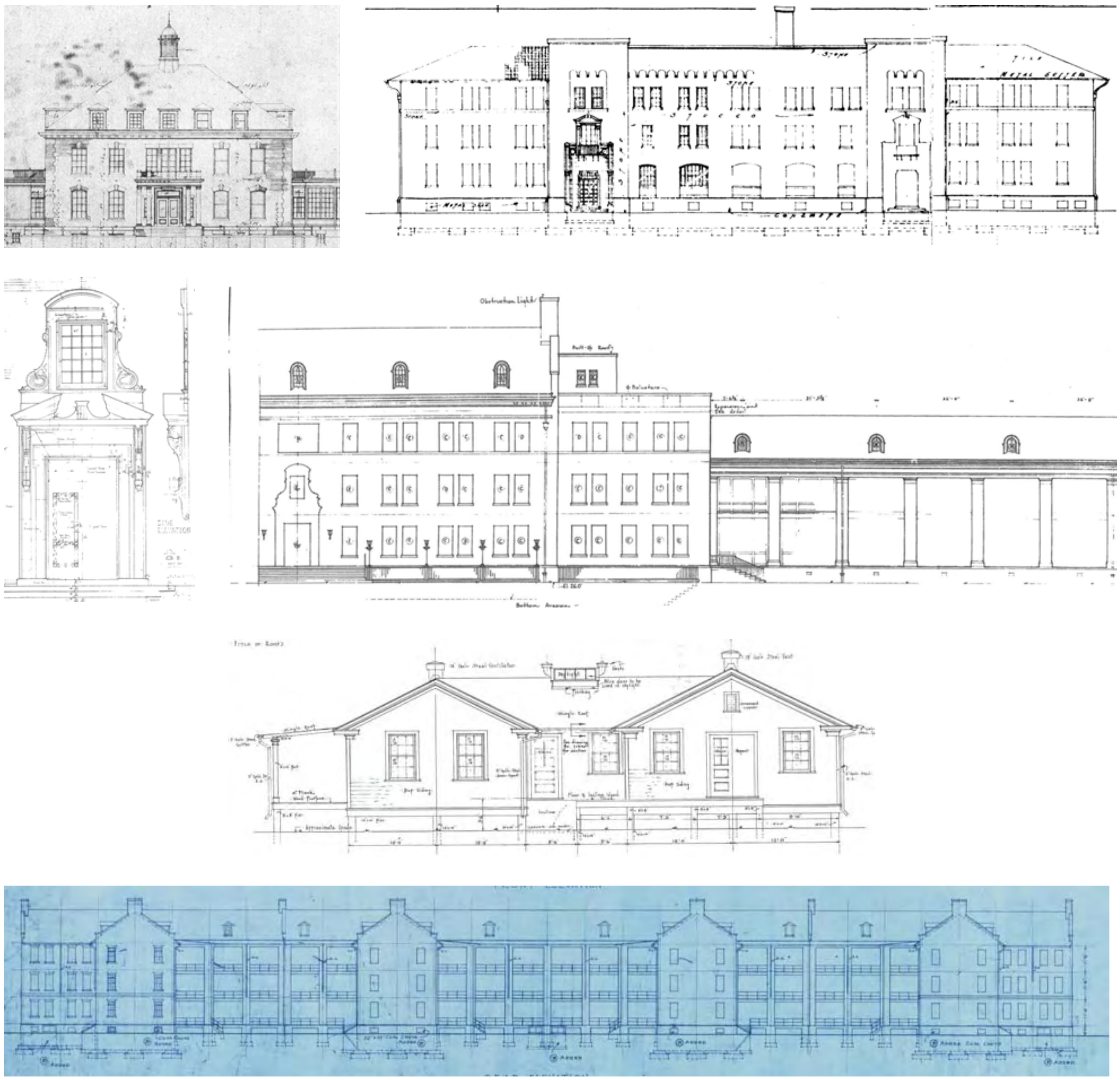


Figure 5: Examples of Group A "Revival" historic architecture in the DoD

Group B

1. By the 1930s, the related styles of Art Deco and Streamline Moderne became fashionable. These styles featured a generally rectilinear shape, but highlighted by rounded building corners and other curvilinear details, flat roofs with parapets, steel

casement windows, and glass block construction. In Europe during this period, the International or Bauhaus style was developing, which following World War II would dominate much of the new architecture in the United States. The International style was a dramatic change from earlier styles and featured long, rectilinear or box-shaped buildings with flat roofs, expansive fenestration, and concrete and steel construction in addition to the traditional brick. In keeping with the Modernist mantra dictating that form should follow function, ornamentation was absent in the International Style.

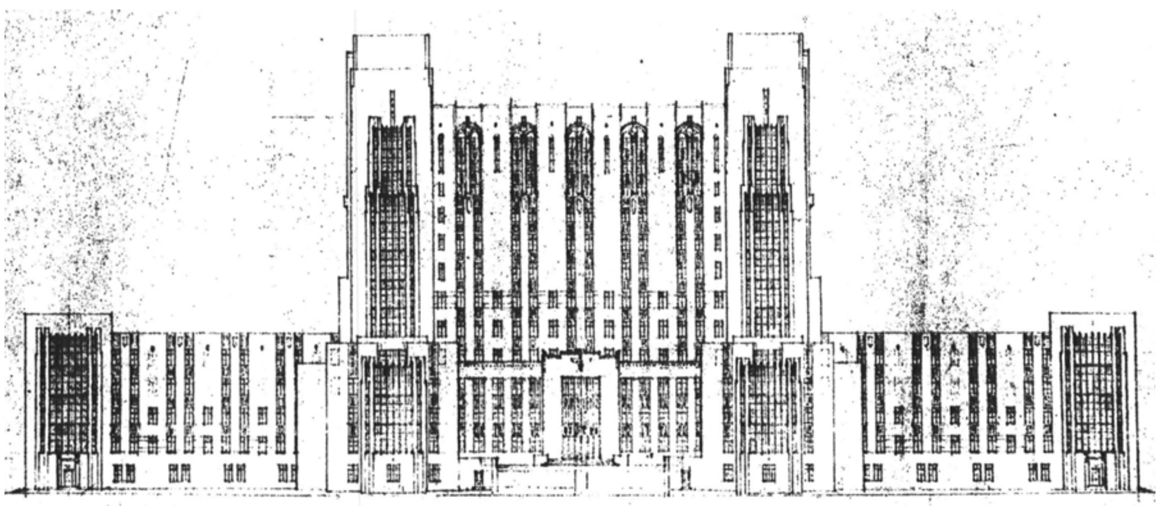


Figure 6: Examples of Group B "Art Deco" historic architecture in the DoD

2. Following the war, "Modernism" began to dominate the world of commercial and industrial architecture. Drawing from the International Style, introduced in the 1930s, modernist architecture splintered into various styles dominated by themes, such as Formalism and Brutalism. In general, the Modernist style featured large-scale, rectilinear massing, with minimal ornamentation, and used new materials, such as concrete and aluminum. Formalist architecture was marked by a strict symmetry, smooth walls, and flat projecting rooflines, while the Brutalist design utilized rough, exposed concrete, broad, expansive walls, and deeply recessed windows.

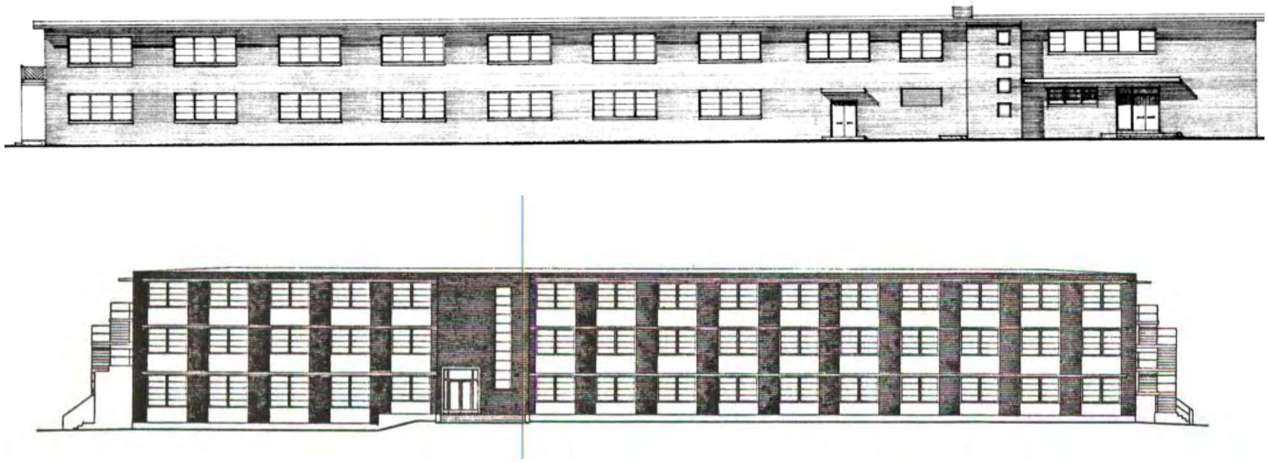


Figure 7: Examples of Group B "Modern Architecture" interpretations in the DoD

Group C

1. Cross-cutting these two eras are the U.S. military-designed and constructed buildings using what we have termed a Military Vernacular style, which relied heavily on standard plans. Although many of these were originally designated as "temporary" buildings (especially during World War II), many have survived into the twenty-first century and have been adapted for other uses. These buildings were generally rectilinear in shape, had a pitched roof with gable ends, and were constructed of wood frame, clay tile infill, or masonry. Fenestration patterns varied depending upon building function and there was virtually no ornamentation in the design.

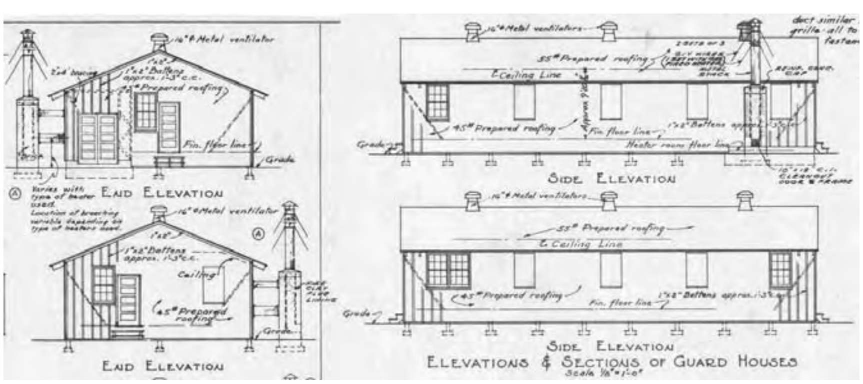


Figure 8: Examples of Group C military vernacular structures

5.3.2 "GREEN" CHARACTER-DEFINING FEATURES

As noted above, specific building styles are in part identified by character-defining features. However, these features often have little to do with energy efficiency. For example, the styles described in Group A are defined primarily by ornate bracketing, elaborate columns, and cast iron metalwork. These features have nothing to do with "green" building techniques. But this is not to say that some character-defining features cannot be green and at the same time function as important style markers. These markers include features such as the tall, multi-light windows and deep porches typical of Victorian era architecture (e.g., Queen Anne, and Italianate) and the long, overhanging rooflines and eaves so characteristic of the Prairie and Bungalow styles.

By the late 1930s and up through the present day, any environmentally inspired, energy-conserving considerations (building orientation, porches, overhanging eaves) were superseded by the increasing use of mechanical heating and cooling systems which kept a building comfortable during a time when energy conservation was not an issue that most architects were concerned about. As such, the post-World War II building styles did not reflect some of the basic "green" building techniques used in the late nineteenth and early twentieth centuries. With the advent of the Green Movement in architecture over the past thirty to forty years, styles have returned to incorporating some of these earlier "green" techniques, albeit with the assistance of modern construction and mechanical systems technology.

Military Vernacular architecture (Group C) rarely exhibited the flamboyance of the architectural styling found in contemporary domestic and prominent commercial structures (although some of the country's more prominent military buildings have incorporated what might be called "high style"). In either case, the availability of modern HVAC systems, together with whether a building was originally to be "permanent" or "temporary," were more likely the driving forces in the military's energy conservation ethics than was style.

Windows and coverings: The fenestration pattern of architectural elevations and the materials, configuration and composition of windows are typically character-defining features. Perhaps the most obvious contributions that windows make to enhancing IEQ are that they provide a means of ventilation when operable, and provide a source of natural daylighting. In fact, a common declaration about historic buildings and sustainability is that operable windows are "inherently green." This may or may not be true, and depends largely on how the historic building is currently being used. When original building systems are intact, operable windows do provide natural ventilation; however, when modern use prevents building occupants from keeping windows open, operable historic windows may actually lower energy performance. For example, in historic buildings that are used for office space that require the use of computers or sensitive equipment, and/or that are located in particularly windy and dusty climates, keeping windows open introduce the problem of damage to this equipment and lowered indoor air quality. Such situations may necessitate HVAC systems, which generally perform more efficiently with windows that do not open or are well sealed, as warm or cool air is easily lost through poorly sealed windows. When climate and use permit, mixed-mode ventilation may be appropriate. This relatively new philosophy in ventilation combines mechanical air conditioning in the same building with operable windows. There are still many obstacles to the use of mixed-mode ventilation methods, which include unfamiliarity with these strategies, complex building operations and controls, fire and life-safety issues, energy codes, and humidity concerns.[67]

In addition, cross ventilation provided by operable windows is not always necessary or desirable. In warm climates where the humidity is low, during the hottest seasons air temperatures are so high that a breeze passing over the skin can add more heat by conduction than perspiration can dissipate. Thus, in these desert climates, fewer and smaller windows and doors are advantageous as this reduces heat and glare.[68] While it is true that when mechanical heating and air conditioning equipment can be turned off and the windows opened, energy consumption at the site will be reduced, this must be balanced carefully with the realities of use and climate.

Historic buildings use windows to provide daylighting along with clerestories, or skylights. Keeping these sources of light unblocked can reduce energy consumption by reducing the need to artificially light interior spaces. Historic buildings may also retain window coverings such as shutters or awnings, incorporated as a means of filtering light, providing cooling through shade, and providing moisture control.

> *Rehabilitation Tips:* Because historic buildings needed windows to provide light to the interior, there is typically enough fenestration to provide good baseline lighting and

---

[67] On mixed-mode ventilation methods, see, "Naturally Ventilated and Mixed-Mode Buildings—Part II: Optimal Control," *Building and Environment* vol. 44, no. 4 (April 2009): 750–61; and the Mixed-Mode Case Studies and Project Database, available at: < http://www.cbe.berkeley.edu/mixedmode/index.html>.

[68] *American Building: The Environmental Forces that Shape It,* James Marston Fitch and William Bobenhausen (New York: Oxford University Press, 1999), pp. 284-87.

views to the exterior. They might not, however, provide the desired levels at current standards and as such a rehabilitation may need to devise methods to provide those higher levels. The best way to enhance the quality of light is through internal devices, as those on the exterior will typically result in having a negative impact on the historic architectural character of the building. Having said this, it is important to analyze the historic features on the interior to ensure that the project will not have negative impacts on any important interior spaces. Methods to enhance the quality of light include devices to bounce or allow more light to the center of the building, light surfaces, and electrical fixtures.

As noted above, the shape of historic buildings typically aids the daylighting, because when the structure was designed and constructed it was the only way to provide light to the interior. As with orientation and climate, this generally cannot be altered, unless an addition is constructed. In most cases, historic buildings provide more opportunity to take advantage of daylighting through the narrow shape and the fenestration patterns.

In addition to daylighting, fenestration patterns and the window units can impact the energy efficiency of the structure. In most cases it is important to preserve the window unit and the architectural spacing/design; as such it is important to conduct an energy analysis (audit, thermography, or modeling) to understand the structure and heat gain/loss. Replacing a historic window should be the last choice; the project team should look for alternatives to increase the efficiency of the building while retaining these character-defining features. Such methods have included new energy efficient windows on the interior (paying attention to moisture control and other factors), adding a low-e film, or other such devices.

Eaves: Wide overhanging eaves serve a number of functions that help to enhance IEQ and protect building materials. Eaves provide shade to walls and windows from the heat of the sun, and provide moisture control by keeping rain and snow off walls and away from windows and doors. The shading effect of overhanging eaves helps to keep interior spaces cool by reducing the amount of heat-producing light that enters through windows, and can also help to filter harsh light, enhancing the quality of daylighting within historic buildings. Wide eaves are a character-defining feature of Prairie style architecture, and can be found in many standard plan buildings dating from 1900 to the 1920s.

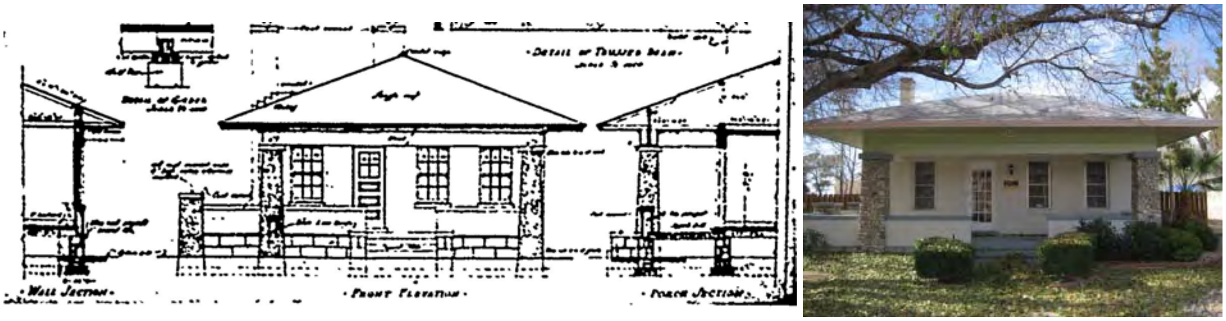


Figure 9: Prairie style bungalow at Fort Bliss, Texas, showing wide over-hanging eaves, standard plan no. 337 [69]

Porches: A common method used in standard plans to help minimize the heat gain from summer sun, particularly for residences and institutional housing, was inclusion of exterior balconies and porches. Many of these buildings were designed with the living spaces on the second floor to catch breezes and to escape the radiant heat from the earth's surface. The effectiveness of porches in limiting heat gain and providing shade is largely determined by the building's orientation and the placement of porches. Current design practice limits east and west exposure, particularly when these elevations on buildings include much glass, as there is much solar heat gain that results from east- and west-facing elevations. However, sometimes historic buildings were oriented east-west to take advantage of breezes and increase ventilation; often in these cases porches were added to historic buildings to provide shade and to help minimize solar heat gain.

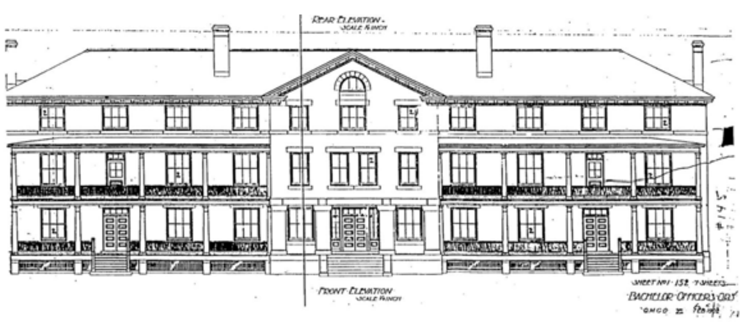


Figure 10: Standard plan for Bachelor's Quarters, 1902, showing full-length porches, a common feature on standard plan barracks until the 1930s[70]

[69] Standard plan 337 reproduced in *A Study of United States Army Family Housing Standardized Plans, Vol. 4,* Bethanie C. Grashof (Center for Architectural Conservation College of Architecture Georgia Institute of Technology, Atlanta, GA, 1986).

[70] U.S. Army Corps of Engineers, "Context Study", p. 233.

Vents: Ventilation is among one of the most important passive systems in many historic buildings, and unfortunately, one whose importance in the system of the building is often overlooked. The most common types of vents are those intended to vent hot air from pitched-roof attic spaces. Examples of common vents found in historic buildings include louvered gable-end vents, ridge-line vents, and dormer vents. When historic vents are removed or closed without providing alternative means of ventilation, the quality of the indoor environment is negatively impacted (the building is hotter and stagnant air has no means of escaping the building), heating and cooling systems run less efficiently, and serious structural damage can occur. Lack of proper ventilation can cause excess moisture to accumulate in attic spaces, damaging building materials, encouraging the growth of mold, and, if the space has been insulated, moisture can saturate insulation causing it to lose thermal effectiveness.[71]

Vegetation: Many historic buildings were accompanied by landscaping that worked in concert with buildings to provide additional shade and protection. Deciduous trees provide shade in the summer months, cooling interior spaces and filtering harsh light, but in the winter months allow for sunlight to enter through windows. In addition, trees and shrubs can help block harsh wind and dust, allowing windows to remain open while helping to mitigate the problems of dirt. While standard building plans did not typically include landscaping, this was a concern and issue of attention in the layout, design, and development of installations. In 1931, the Construction Division of the Quartermaster Corps established national design criteria for landscaping military installations. Among other design principles, this office advocated the use of trees and shrubs to "moderate harsh environmental conditions through soil erosion control and planting trees for shade."[72]

> *Rehabilitation Tip*: Coverings, eaves, porches, and vegetation all contribute to tempering daylighting and heat absorption within a historic building. The original features may have been designed using more qualitative measures than are available to the modern architect or engineer. In general, such features typically provide the necessary baseline shading to keep unwanted direct light from the interior. However, it would be useful to a green retrofit project to analyze the sunlight and how it hits a building. This can aid in design decisions about daylighting and in understanding how enhancing the daylight to the interior may affect the historic building.

[71] The attic is adequately ventilated when the net area of ventilation (free area of a louver or vent) equals approximately 1/300 of the attic floor area. National Park Service, Preservation Brief #3, p. 6.

[72] Standard landscaping plans for at least three building plans were developed in the mid 1930s. U.S. Army Corps of Engineers, "Context Study", pp. 57-58.

5.4 SUMMARY

There are environmental and human variables, basic building components of various types and made from diverse materials, and architectural character-defining features that, in the right combinations, can work to make historic buildings green. The overall sustainability of historic buildings must be considered in a context that takes into consideration the whole building, recognizing that historic builders created buildings that worked as systems. When making alterations to historic buildings that are meant to increase the energy performance or IEQ, careful consideration should be given to the original integrated designs of historic buildings.

Modern notions of "greenness" and "sustainability" have complicated interrelationships between elements of historic building systems. Altering daylighting can affect the HVAC system and energy efficiency; creating privacy, for example by erecting office partitions, can affect ventilation and ambient conditioning; and if computers, new lights, and more people are added to a building they can affect energy and other operational aspects. Each building system element that is altered can potentially affect other system elements and inhibit the desired performance goals. Adding preservation to the mix can complicate the interrelationships, but may also simplify them. If a project design team cannot introduce partitions into the interior because the open space is considered historic, or cannot alter window openings because it will adversely affect the exterior architectural character, there are fewer architectural features that can be altered and a more direct path to the necessary solution. So, it is important to define the project parameters from a preservation point of view, as well as outline the green architecture goals. The historic features can both support the goals through using or restoring those elements and they can provide a more direct path to a solution by limiting what can be done within the building. It can be a more interesting challenge to meet the sustainability goals while preserving DoD history, and can lead to unique and beneficial solutions.

While the building is being analyzed for the existing mechanical, electrical, structural, plumbing and architectural code/design issues, it should also be analyzed for the historic features and character that will support and provide design parameters for the project. Any project developed for a historic property should follow the *Secretary of the Interior's Standards for the Treatment of Historic Properties*, discussed in Chapter 2. Most sustainability projects will follow the standard, Rehabilitation, but might rely on other standards to restore or preserve features.

6.0 CASE STUDY ENERGY MODEL

Following on the belief that buildings constructed prior to 1920 are the most energy efficient, an early goal of this study was to use computer modeling to provide EPA Energy Star ratings for DoD buildings based on property types and representative historic styles.[73] In order to develop and test a computer model that would provide such ratings for building types, a test case was conducted using a typical, brick masonry barracks building constructed in 1895. The results of the case study were not only contradictory to the original assumption that historic buildings built prior to 1920 were the most energy efficient, they were so staggering as to force a re-conceptualization of the purpose and usefulness of the computer model. Even more importantly, the test case results forced unexpected conclusions about the ways in which historic buildings are green and the best methods for improving their energy efficiency.

When initially run through the energy rating models, the test case building received an EPA Target Finder rating well below average—an Energy Star rating is 75, an average rating is 50, and the unmodified test case building rating was 4-6. The next question asked was, is it possible to institute energy conservation measures that would both protect the historic integrity of the test case building and raise the target finder score to that of an Energy Star rating? Using a number of potential energy conservation measures (ECMs) (discussed in detail below), the test case building was run through multiple energy modeling iterations. The findings revealed that even when all the measures were combined, the building was unable to reach the Energy Star rating; however, these measures could significantly improve the building's energy efficiency, raising the target finder rating above the average score with potential for great savings in energy and cost.

The results of the initial Target Finder test and Energy Model that considered various ECMs discussed below make it clear that it is unrealistic to make blanket statements about historic buildings and their energy efficiencies. Because there are building management professionals at either end of the scale–from those who believe historic buildings are not sustainable to those who think historic buildings are the most sustainable—it is all the more important to have accurate and complete data about how historic buildings perform in terms of energy efficiency and how their performance can be improved while protecting historic integrity. The Energy Model test case can act as one tool for building management to understand and assess the

[73] See footnote 1.

energy efficiency of historic buildings, and, combined with a full understanding of how historic building systems operated in other areas of sustainability, can help to make historic buildings deeper shades of green.

6.1 BUILDING 56, FORT MACPHERSON

The Case Study Energy Model was based on Building 56 at Fort MacPherson. This building was chosen because it is a typical 1880s masonry building, a full set of drawings were available to the project team, and because there was enough information about original construction and energy upgrades to support the modeling process. Input parameters for creating the model were taken from available information and drawings. When information was missing, assumptions were made which reflected what would have been typical of similar buildings from the same time period (detailed descriptions of the assumptions integrated into the computer model are included in the Appendix "Supplemental Case Study Information").

The construction of Building 56 at Fort McPherson was completed in 1889. The rectangular brick building is two stories tall. It was originally designed with a brick fire wall that divided the building: the building plan on either side of that wall was a mirror image of the other, with each side possessing a stair hall at the center. The second floor included one large dormitory room that opened off each side of the stair hall, each room accommodated approximately twenty-four men. The first floor included a large day room at the front elevation, which fronted the parade ground, and several smaller spaces. These smaller spaces included living quarters for a non-commissioned officer, an office, an armory, a bathroom with a separate wash room, a large mess hall, kitchen, kitchen store room, and a cook's room on the opposite side of the stair hall. The lavatories were in a separate, small privy building behind the barracks.

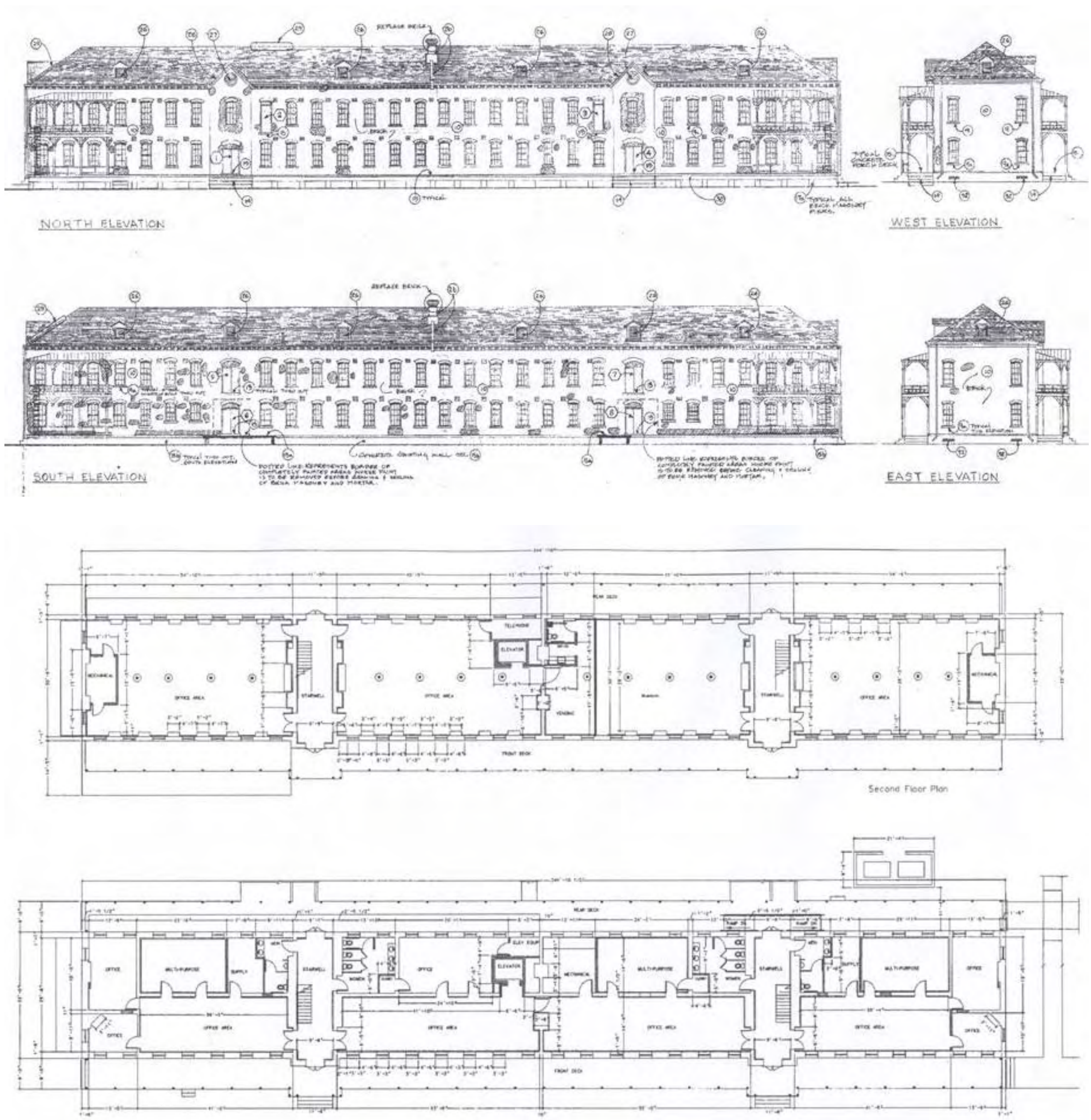


Figure 11: Building 56, Fort MacPherson elevations and floor plans

Originally, the building was heated by fireplaces on the first floor and pot-bellied stoves on the second floor. Ventilation and cooling would have been accomplished by opening windows and doors. The building had wood floors, and beaded tongue-and-groove wainscot and corner beads with plaster walls above the wainscot. The first floor ceilings were tongue-and-groove, while on the second floor, ceilings were plaster.

Although the functions of the various rooms changed over time, the original floor plan appears to have remained intact until the 1950s. In 1957, drawings were prepared for the installation of new bathrooms. At this time, some walls were moved, and several doors and windows were removed and/or altered. By 1978, partitions were added to subdivide the large open rooms and the fireplaces and wood stoves had been removed.

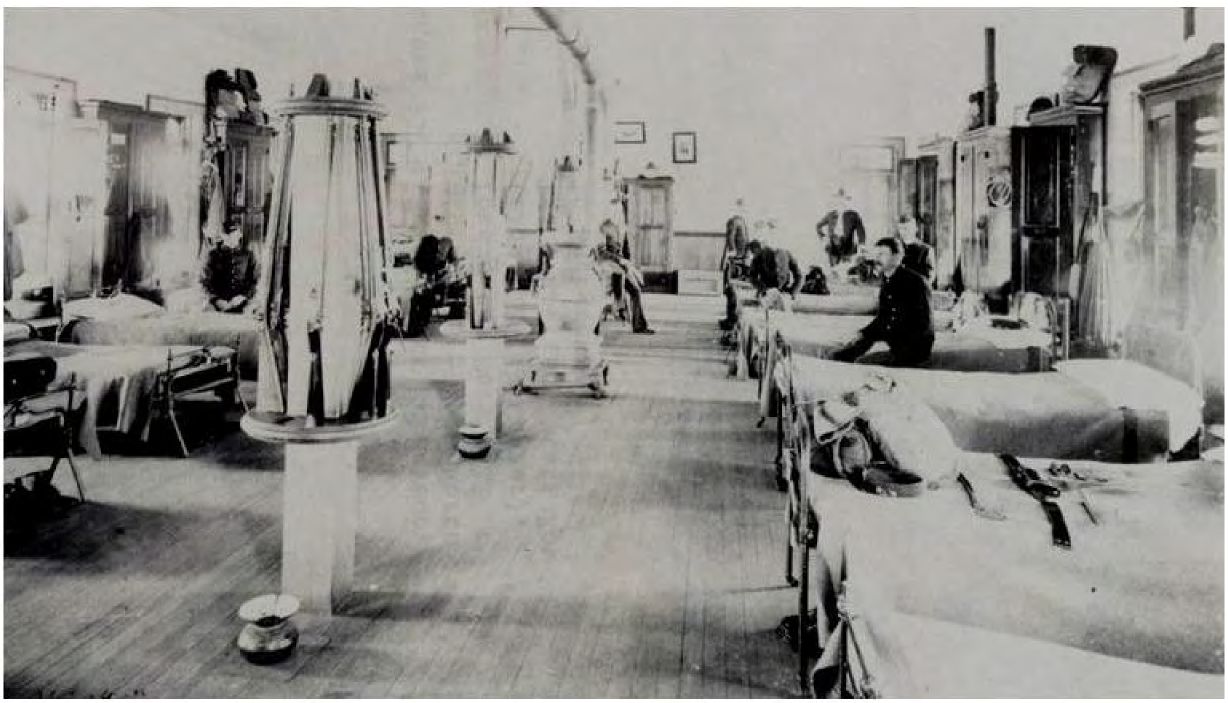


Figure 12: Interior photograph of Building 56 at Fort MacPherson, ca. 1900

6.2 BASELINE ENERGY MODEL SIMULATIONS

The first energy model compared the baseline building's energy use to energy consumption when one of, or a combination of, three ECMs were instituted. This section briefly explains the baseline data, and discusses the three ECMs simulated in the model, as well as the results of the model simulations.

6.2.1 THE BUILDING

Buildings operating in the late nineteenth century included little or no energy consuming equipment, although heating was provided by fireplaces and wood/coal burning stoves. Modeling the fireplaces and wood/coal burning stoves was problematic, as rates of burn and efficiency of the units are unknown. While assumptions could be made to approximate the BTUs (British Thermal Units) required to heat the building with wood or coal, rather than compare this use to modern standards of energy use, it was more appropriate to model the building from a period when an HVAC system had been installed. Therefore, it was determined that the best baseline data would be to model the building from a retrofit that provided enough data to develop a useful model. The most thorough plans for this scenario were from 1978; thus, the baseline data is from the 1889 Fort McPherson barracks building as it was remodeled in 1978 to perform as offices with a modern HVAC system. The parameters for the baseline model included a two-story building with walls constructed of solid mass, a 26% glazing ratio, and a high internal-load (which simulated a space used as office space rather than as residential space). In addition, the baseline was modeled in Climate Zone 4, which is the zone in which Atlanta is located, and was entered into the model as having an east/west orientation, meaning that its long axis stretches east to west (a detailed breakdown of input parameters and baseline data for the retrofitted building is provided in the Appendix "Supplemental Case Study Information").

6.2.2 THE BUILDING USE

The Fort McPherson building, like many other buildings owned by the DoD, has seen various usages and occupancy types. For this reason, both simulated office and residential conditions were required for the energy model. At the time the model was created, the most current (2003) CBECS National Averages for both office and residential buildings were obtained in order to gain a scale of magnitude when interpreting the model output reports. National average energy use intensities (EUIs) for both building types are stated below:

Office Building: 92.9 kBtu/sqft/yr[74]
Residential Building: 48.5 kBtu/sqft/yr
Annual Simulated Energy Consumption: 180.2 kBtu/sqft/yr

[74] kBtu/sqft/yr: Kilo (a thousand) British Thermal Units per square foot per year.

Instead of simulating residential conditions in addition to office conditions, CBECS data for office and residential buildings was used to determine a multiplier or coefficient to apply to simulated office building output in order to gain an approximate residential usage of the same building. The coefficient applied to the residential buildings based on CBECS data is 52.2%. What this means is that for every output from a simulated office building only 52.2% of associated energy was reported as the anticipated equivalent residential consumption. Calculation methodology for this CBECS-based coefficient is as follows:

48.5 kBtu/sqft/yr (Residential Building) ÷ 92.9 kBtu/sqft/yr (Office Building) = 52.2%

6.2.3 ENERGY CONSERVATION MEASURES

Three iterations of modeled energy conservation measures (ECM) were decided upon by the project team. Evaluation of each iteration against the Fort McPherson building baseline data was performed to study and compare energy performance between the baseline design (1978 Building) and the baseline with energy conservation measures applied to them. A final iteration with all the modifications combined was also conducted. Because this building is located at Fort McPherson, the climate criteria and other variables were unchanged during this part of the study.

ECM Iteration 1: "Double Glazing"
All windows in the baseline model (single-pane) were replaced in the model simulation with double glazed windows with the following light and thermal transmission characteristics. The window frame remained the same between the baseline and ECM Iteration 1 (wood).

Table 2: Energy Model double glazing

Property	Baseline	Iteration 1
Gap Fill Between Panes	- - -	¼" Air
U-Value (glass)	1.11	0.57
U-Value (with frame)	1.21	0.76
Frame	Wood Frame	Wood Frame
Solar Heat Gain Coefficient	0.86	0.76
Visible Transmittance	0.90	0.81
Solar Transmittance	0.84	0.70

This modification produced a decrease of 7.17% in Annual Energy Consumption (8.8 kBtu/sqft/yr) and a decrease of 4.41% in Annual Electric Energy Use (11,351 kilowatt hours [kWh]). The intent of this ECM was to increase the overall building envelope insulation value, reducing the amount of energy that is exchanged with the exterior. While the model indicated significant energy savings in this cooling dominated climate zone, if the model was located in a Mixed or Heating Dominated climate zone, energy savings related to window improvements would be greater. Double glazed windows would offer a greater thermal barrier to cold outdoor conditions, further preventing heat exchange with the exterior.

ECM Iteration 2: "R-38 Roof Insulation"
The baseline was modeled with no insulation on the roof; for this iteration R-38 fiberglass batting roof insulation was added to the simulation (no radiant barrier used). This produced a decrease of 1.47% in Annual Energy Consumption (1.80 kBtu/sqft/yr) and a decrease of 1.14% in Annual Electric Energy Use (2,936.0 kWh). The intent of this ECM was to increase the overall building envelope insulation value to reduce the amount of energy that is exchanged with the exterior. If the model was located in a Mixed or Heating Dominated climate zone, the energy savings related to roof insulation would be greater due to ability to limit heat exchange with the exterior. In cooling dominated climates, such as in Atlanta, roof insulation improvements like this one highlight an early diminishing point of return.

ECM Iteration 3: "LPD: Light Power Density"
Based on the "Code for Energy Conservation in New Building Construction" document from 1977 (included in the Appendix "Supplemental Case Study Information"), the LPD value used for the baseline model was 2.75 watts per square foot (W/sqft). This iteration used an LPD value of 1.0 W/sqft; based on the ASHRAE Standard 90.1 – 2007 for Office buildings. This produced a decrease of 7.33% in Annual Energy Consumption (9.00 kBtu/sqft/yr) and a decrease of 14.52% in Annual Electric Energy Use (37,361 kWh). The intent of this ECM was to decrease the amount of energy used for lighting in the building. This ECM will also decrease net and peak cooling loads, resulting in cooling and ventilation energy reductions as well. Reduced cooling loads and cooling season energy use will also result in longer equipment life and fewer operations-based repairs and overhauls. In heating dominated climates, reductions in internal load will require additional run-times of heating and ventilation equipment during heating months.

ECM Iteration 4 – "Combination"
This iteration contained all changes made in the previous iterations (Double Glazing + R-38 Roof Insulation + 1.0 LPD). This simulation produced a decrease of 15.81% in Annual Energy

Consumption (19.40 kBtu/sqft/yr) and a decrease of 20.04% in Annual Electric Energy Use (51,581 kWh).

6.2.4 SUMMARY OF RESULTS

The results of this comparison are outlined in the table below. The first column shows the different iterations that were simulated, indicating which variable changed in the model. The second column, titled "Energy Consumption," includes the total energy that was consumed over the year. This is an average expressed in kBtu's consumed per square foot per year, in order to relate to the EPA Target Finder. The third column, titled "Energy Use," includes the total Electrical Energy that was used by the building in the year. It is expressed in Kilowatt Hours (kWh); the most common unit used when energy is reported by electric utilities to consumers. The third and fourth columns in the table illustrate the likely effects of energy conservation measures if applied to the same building used for residential purposes (such as barracks). To obtain these results, the residential coefficient is applied to the corresponding performance of the office building iterations. This coefficient is 52.2% of the office building's consumption.

Table 3: Case Study energy consumption

Reference Energy model	Office Building		Residential	
	Energy Consumption	Electrical Energy Use	Energy Consumption	Electrical Energy Use
1978 McPherson Baseline Building	122.7	257,354	64.1	134,338
Iteration 1: Double Glazing	113.9	246,003	59.5	128,413
Iteration 2: R-38 Roof Insulation	120.9	254,418	63.1	132,806
Iteration 3: Reduced Light Power Density	113.7	219,993	59.4	114,836
Iteration 4: Combination of all 3	103.3	205,773	53.9	107,413
Units of measure	kBtu/sf/yr	kWh/yr	kBtu/sf/yr	kWh/yr

Because the case study building is set at Fort McPherson in Atlanta, Georgia, ECMs related to natural gas savings have negligible affects on heating energy consumption. In mixed or heating dominated climates the energy conservation measures in this study would produce more measurable energy savings. Note that natural gas reporting is for domestic hot water only; because the building is on a central boiler loop, space heating energy is not reported here.

Figure 13 below shows a comparison of the output results generated by the different models. The green bar (left) shows the Annual Energy Consumption (kBtu/sqft/yr) as a percentage of the baseline model. The orange bar (right) shows the Annual Electrical Energy Use (kWh), also as a percentage of the baseline model for each iteration. As illustrated, decreasing the LPD for the model produced the best performance of individual measures, followed by improving the glazing to double pane. Adding roof insulation did not produce measurable results due to climatic zone factors as explained above. The combination of all conservation measures produced the best performance, as would be expected.

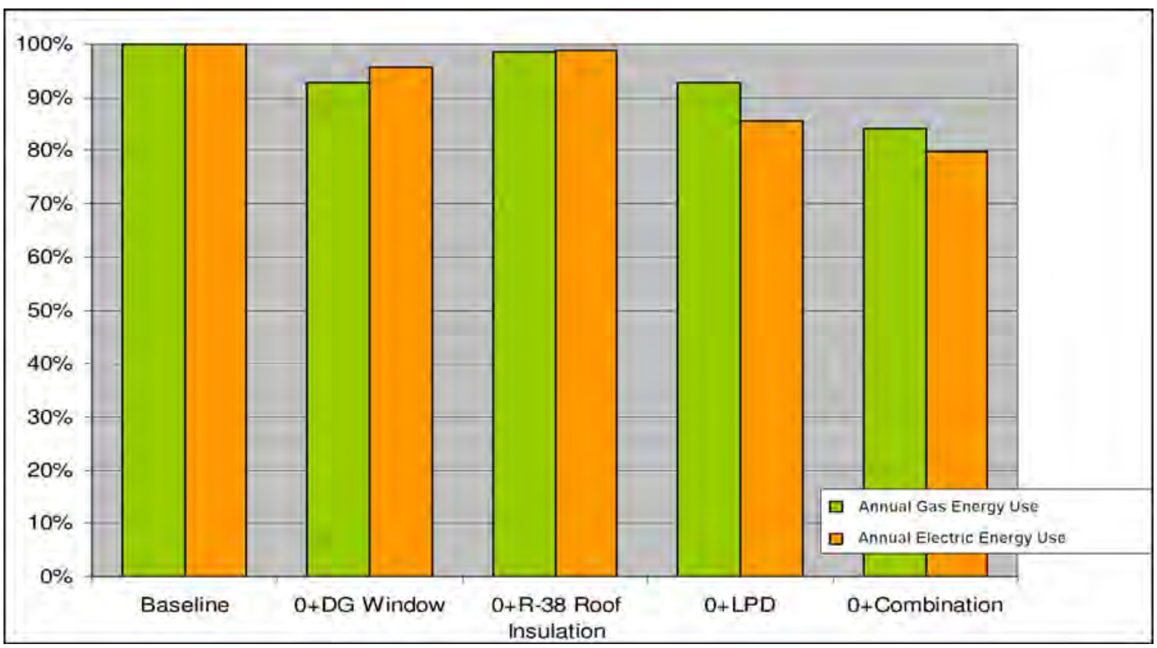


Figure 13. Side-by-side comparison of ECM iterations results graph

The baseline iteration and iteration 4 (with combined conservation measures) were rated in Target Finder using data generated by the energy model simulation outputs. The baseline model was given a 4-6 energy performance rating. The score is considerably lower than the national average for buildings of the same type. Iteration 4 was given an energy performance rating of 29, still a considerable amount below a comparable modern building that would average an energy performance rating of 50 (see Appendix "Supplemental Case Study Information").

6.3 ADDITIONAL VARIABLES AND ECMS

Originally, the project team intended to model a number of building types modifying each of the ECMs and accounting for climate and orientation. Because (1) this study would have produced a plethora of data (see, for example, the output matrices in the Appendix "Supplemental Case Study Information" which present the data for this single case study building), and (2) the initial Target Finder ratings and average Target Finder ratings that were produced with ECMs instituted were still below average, the project team determined it would be more productive to model the same building across multiple climates in order to get a more nuanced picture of how the various ECMs interacted with climate, orientation, and building load.

In the new output matrix, ECM iterations were applied in each of five U.S. climate zones and applied to two orientations (constituting ten Baseline Models). All of the iterations also incorporated a residential multiplier to determine the effects of varying internal loads. In addition, two additional ECMs were added to the simulations: increased wall insulation, and a combination of ECM Iterations 1-4. In total, an additional sixty models were simulated. After these results were tabulated, the model was later expanded further to consider two extra ECM iterations: localized HVAC and a combination of all six ECMs.

6.3.1 CLIMATE ZONES

The climate zone in which the building is constructed and operates plays an important role in energy performance. Five zones have been developed by the DOE based on the number of "heating degree days" (HDD) and "cooling degree days" (CDD). Below is an annotated map including the geographic locations of each city used to simulate each U.S. climate zone in the model, followed by the eQuest weather file and associated zip codes:

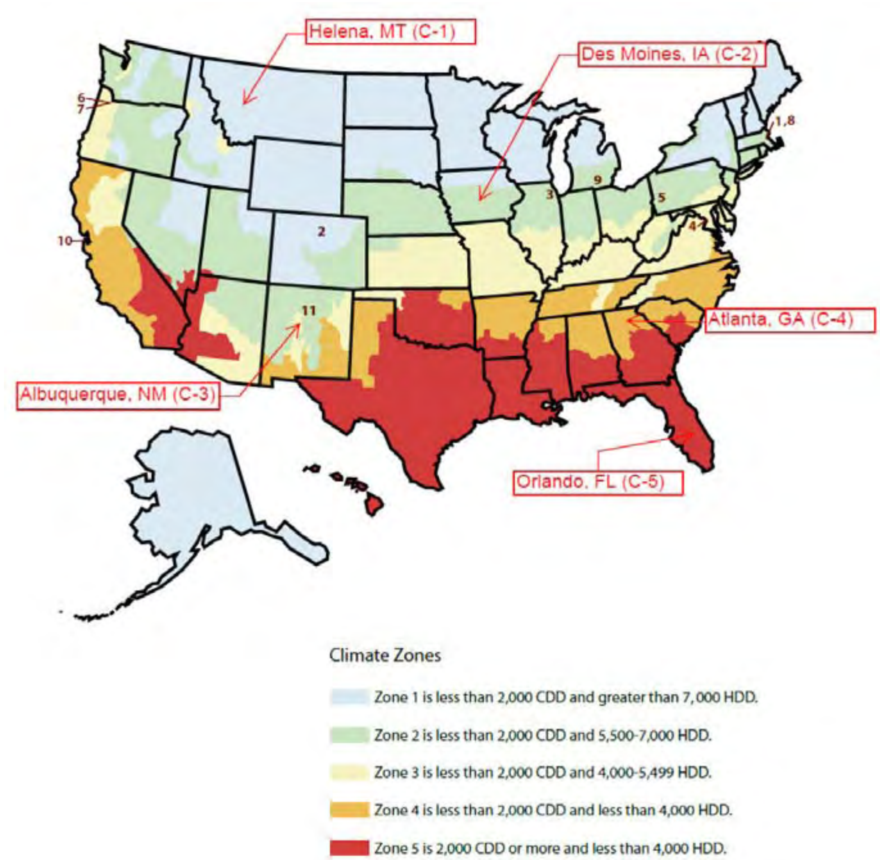


Figure 14. Map of climate zones

eQuest Climate Zone Weather Files for Simulation:
- Climate Zone 1: WeatherFile = "TMY2\HELENAMT.bin" (Zip Code = 59601)
- Climate Zone 2: WeatherFile = "TMY2\DES-MOIA.bin" (Zip Code = 30341)
- Climate Zone 3: WeatherFile = "TMY2\ALBUQUNM.bin" (Zip Code = 87123)
- Climate Zone 4: WeatherFile = "TMY2\ATLANTGA.bin" (Zip Code = 30341)
- Climate Zone 5: WeatherFile = "TMY\ORLANDFL.bin" (Zip Code = 32801)

6.3.2 ORIENTATION

The expanded model considered the ECMs using both a north/south orientation and an east/west orientation. As the results (presented in the next section) reveal, the interplay of climate and orientation have important impacts on the energy efficiency of the building as a whole and of the various ECMs.

6.3.3 HIGH LOAD/LOW LOAD

As in the first Energy Model that considered only three ECM iterations, the expanded model considered the ECMs using a high load, or office building consumption level of energy, as well as a low load, or residential building consumption level of energy. As explained above, these load values were calculated using CBECS National Averages for office and residential buildings to determine a coefficient by which the office use could be multiplied to calculate a relative residential use load (the coefficient is 52.2%—formula given and explained in section 6.2.2).

6.3.4 ADDITIONAL ECMS

ECM Iteration 4: R-19 Wall Insulation:

The Baseline Model was developed with no insulation on the exterior mass walls. For ECM Iteration 4, the addition of R-19 batt wall insulation in a furred-out interior metal stud was simulated. The intent of this ECM was to increase the overall building envelope insulation value to reduce the amount of energy that is exchanged with the exterior.

ECM Iteration 5: Combination of Iterations 1-4:

This iteration contained all changes made in the previous iterations (Double Glazing + R-38 Roof Insulation + 1.0 LPD + R-19 Furred-Out Exterior Wall Insulation). The intent of this iteration was to combine all previous variables into one in order to review and compare with each iteration individually; this iteration is largely used to illustrate the anticipated maximum effectiveness of a building incorporating all identified ECMs.

ECM Iteration 6: Localized HVAC:

This iteration included the modifications for localizing HVAC as illustrated in Table 4:[75]

[75] Because of the various options for zoning proposed by new HVAC systems, this ECM was generalized to one packaged roof-top unit per existing zone (corresponding to previous HVAC zoning layouts, including zones that were previously considered "exhaust-only" – i.e. restrooms).

Table 4: Localized HVAC

Cooling Efficiency	SEER[76] of 12.0 / 10.2 EER[77]
Heating Thermal Efficiency	80% Et[78]
Temperature Limits	65° F High-Limit and 45° Low-Limit on Economizer Cycle
Outdoor-Air damper closed at night	
Constant Volume Fans	
VAV zone-boxes, reheat, heat-recovery, or evaporative pre-cooling	

Additional HVAC energy savings could be realized based on further "off-the-shelf" controls; such as heat-recovery, unoccupied thermostat set-backs, demand controlled ventilation, among other additional controls.

ECM Iteration 7: Combination of all ECMs:
This iteration combined the Localized HVAC, Double Pane Windows, R-38 Roof Insulation, Reduced Lighting Power, and R-19 Wall Insulation. The intent of this iteration was to determine the maximum energy savings possible.

6.3.5 SUMMARY OF RESULTS

The model was applied by simulating each of the seven ECM Iterations in each climate zone, for each orientation, and at each load. This process is illustrated in Figure 15.

[76] Seasonal Energy Efficiency Ratio.
[77] EER = Energy Efficiency Ratio. The equation depicted is the Commonly Accepted Cooling Efficiency Conversion Formula from SEER to EER → EER = SEER * 0.85.
[78] Et = Thermal Efficiency.

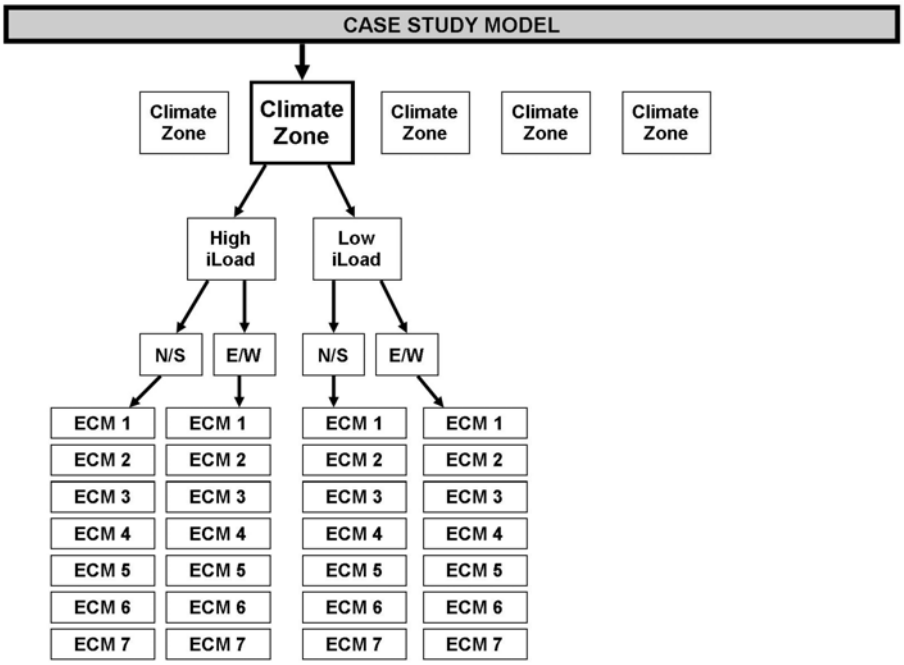


Figure 15: Process for expanded Energy Model simulation

The results revealed that ECM iteration 6, adding a localized HVAC, is by far the most effective individual ECM. The measure with the next highest energy savings was the addition of R-19 Batt wall insulation; however the savings were only one fourth of that produced by adding the localized HVAC. The least effective measure was the addition of R-38 batt roof insulation, which produced on average only a 1% energy savings. While these ECMs were effective in all climate zones, simulations based in cooling dominated climate zones yielded the greatest savings when localized HVAC was simulated (see Appendix "Supplemental Case Study Information").

Table 5: ECM energy savings

ENERGY CONSERVATION MEASURE	AVERAGE ENERGY SAVINGS	ENERGY SAVINGS RANGE	
		MAX	MIN
ECM Iteration 1: Double Pane Windows	6%	6%	5%
ECM Iteration 2: R-38 Batt Roof Insulation	1%	2%	1%
ECM Iteration 3: Reduced lighting Power	3%	5%	1%
ECM Iteration 4: R-19 Batt Wall insulation	11%	14%	7%
ECM Iteration 5: Combination of ECMs1-4	22%	24%	20%
ECM Iteration 6: Localized HVAC	42%	72%	31%
ECM Iteration 7: Combination of all ECMs	54%	77%	47%

While none of the ECMs yielded an Energy Star Score capable of qualifying for an Energy Star rating (score of 75), or considerable savings compared to the 2003 CBECS survey, each ECM did yield a considerable projected energy savings from the baseline building. Further, for many of the simulations across climates, the combination of ECMs (Iteration 7) produced a considerable amount of annual energy savings (see Appendix "Supplemental Case Study Information").

6.4 CASE STUDY CONCLUSIONS

The EISA-mandated goal of a 30% reduction in energy consumption by 2015 can be achieved by simply removing the building from older, inefficient central plants and providing buildings with new localized equipment that meets or exceeds current efficiency standards. It may be possible to still meet the energy efficiency goal by retaining an existing central plant, however, central systems that use old equipment would have to be replaced with new higher efficiency equipment and be analyzed as a complete campus system. (In the case study, the Central Plant was modeled with efficiencies appropriate for the 1978 baseline parameters; for specifics, see Appendix "Supplemental Case Study Information".) Existing central plants generally have sustainable and energy efficient characteristics as they centralize maintenance, take advantage of load diversity across a campus, and can generally allow for greater cooling efficiencies by using water cooled condensers, which are not always practical from a cost or maintenance standpoint on smaller individual buildings. Making this one change—updating outdated equipment be it on a central loop or localized HVAC—raises the Target Finder scores significantly from the original baseline scores.

Table 6: Case Study Target Finder scores with localized HVAC

Simulation—Iteration 6: Localized HVAC							
#	Orientation	Climate Zone	City, State	Zip Code	Electricity (kWh)	Gas (Therms)	Target Finder Score
1	E/W	1	Helena, MT	59601	190,238	16,164	33
2	E/W	2	Des Moines, IA	50301	206,677	14,658	32
3	E/W	3	Albuquerque, NM	87123	198,578	6,586	50
4	E/W	4	Atlanta, GA	30341	204,435	6,951	45
5	E/W	5	Orlando, F	32801	226,177	1,778	53
6	N/S	1	Helena, MT	59601	202,641	16,282	29
7	N/S	2	Des Moines, IA	50301	215,382	14,843	29
8	N/S	3	Albuquerque, NM	87123	212,557	8,719	38
9	N/S	4	Atlanta, GA	30341	212,462	6,910	42
10	N/S	5	Orlando, FL	32801	234,393	1,766	50

Some of the most commonly performed retrofits, such as adding roof insulation and replacing windows, may not be as cost effective as other retrofits or combinations of other energy saving measures. The wide variation by climate zone in the possible target scores achieved by decentralizing heating and cooling (see above table, for example a score of 50 was earned in climate zone 3 versus score of 32 in climate zone 2) suggests that a careful analysis of potential energy and cost saving is warranted on a building-specific basis before such measures are taken.

7.0 MEETING DOD SUSTAINABILITY GOALS IN HISTORIC BUILDINGS

As we have presented, there are many features and aspects of historic buildings that were designed to interact with and take advantage of the environment in order to provide a level of comfort to the occupants. While they were not thought of as "sustainable" or "green" when they were constructed, they are now features that can be used to support the ultimate greenness of the building as it is being rehabilitated to modern standards.

It is unlikely that a DoD building would be restored to its original heating, cooling and lighting functionality; however, to take advantage of its green characteristics, it is important to understand how the structure originally operated. By understanding the original functionality of the building, project designers can better use the architectural elements that may aid in making a rehabilitation design less costly and/or more effective.

For example, there exists in the DoD historic building inventory, an 1890s barracks building that originally incorporated roof vents and dormers (possible character-defining features) to aid in the natural ventilation and cooling process. During late 20th century renovations, the building lost those features. In addition, a condenser that was rated for outdoor use only was installed in the attic, which provided mechanical waste heat in addition to the natural heat that was rising into that shared space. Because the vents and dormers had been removed, the attic became a place where heat was stored, rather than a functional feature that was originally designed to remove excessive heat from the building. Because the attic could not vent heat, the mechanical system in the building could not function efficiently in winter or summer. The historic character was adversely affected and the net result for the mechanical system did not provide the level of comfort desired or energy efficiency.

If a renovation project were completed on that building today, a targeted design process could allow for the restoration of the ventilation features, which would restore some of the historic character and support the efficient operation of a modern HVAC system. To do this effectively a mechanical engineer would have to review the historic operation and configuration of the building to determine whether the historic features and devices could support the programmed design. It is also likely that the attic would not have been the only architectural feature altered over time. Other changes, such as adding partitions or sealing windows may have also been made which would have affected how the building operates. All of these would have to be taken in to account when designing a new system.

The same would be true for daylighting and windows. If window configuration has been altered or partitions have been added, the original daylighting effect would not be intact. If the daylighting effect was an important aspect of making the building "green," then the partitions would need to be removed. Alternatively, if the partitions were to remain, the architect would have to design alternatives, such as internal windows or skylights, to bring daylight to the interior. In either case, the number of foot-candles required in modern buildings is greater than that which would have been required historically. As such, whether the partitions remain or not, any daylighting modifications would be "bounced" to the interior through means discussed in Chapter 4. So, while historic buildings already include basic requirements for daylighting – a high ratio of window to wall area and narrower floor plans to allow for maximum penetration – there are other techniques that may need to be applied to take full advantage of the historic feature to meet the green architecture potential.

Using the complexities discussed above as an example, one should note the importance of defining the project's sustainability goals and preservation needs in order to create the best possible historic preservation/green architecture project. Defining these early in the planning of a project and balancing them as the design development and construction documents progress (30, 60, 90%) will ensure the project meets the Secretary's Standards and the sustainability goals for the building.

7.1 ENERGY GOALS AND EISA 2007

While it is important to identify the character-defining features, it is equally important to define the sustainability goals for the building. Doing so will help to determine if the sustainability goals could affect the historic architectural features, and can therefore help to reduce or remove the likelihood that sustainability projects pose adverse effects to historic preservation. Defining sustainability goals will also allow a project team to meet the commissioning requirements outlined in EISA 2007 (see discussion in Chapter 2).

In order to ensure proper commission required under the law, it is important to document the design, intent, and operational needs to ensure the functional systems are property operated and maintained. To develop the most effective system, it is important to understand the building energy and passive operational characteristics, intended use, and energy goals. Defining these can also help the design team to identify issues that may need to be addressed in the NHPA Section 106 compliance process.

In the DoD, there are specific mandates beyond commissioning that must be met with regard to sustainability. When determining sustainability goals for a building, these mandated items should be primary, while other aspects of sustainability, such as IEQ, which can enhance the project and support the goals of the Federal MOU, can be secondary. Both are important, but if IEQ is the only focus, the mandated energy requirements will be missed. The significant aspects of EISA 2007 that affect historic buildings include increasing energy efficiency and promoting renewable energy.

7.1.1 ENERGY EFFICIENCY

To promote energy efficiency, EISA 2007 requires that the "energy consumption per gross square foot of the Federal buildings of the agency in fiscal years 2006 through 2015 is reduced, as compared with the energy consumption per gross square foot of the Federal buildings of the agency in fiscal year 2003, by the percentage specified in the following table":

Table 7: EISA 2007 energy reduction

Fiscal Year	Percentage Reduction
2006	2
2007	4
2008	9
2009	12
2010	15
2011	18
2012	21
2013	24
2014	27
2015	30

Source: Subtitle C, High-Performance Federal Buildings, Section 431. Energy Reduction Goals for Federal Buildings and Section 543(a) of the National Energy Conservation Policy Act (42 U.S.C. 8253(a)(1)).

Typically CBECS is used to define the 2003 baseline. To identify the baseline percentage for a historic building, the project team working on a sustainability rehabilitation would use CBECS to find a similar building to the historic property they are rehabilitating: the CBECS energy use number becomes the 2003 baseline. From that they could use the EISA 2007 energy percentage reduction number to generate the energy goal for the project. This energy goal can help determine which mechanical systems would best meet the goal and in turn which historic architectural features might support that goal.

Some tools that could aid in better understanding the existing building, beyond the character-defining features, include computer energy modeling, thermography, and energy audits.[79] Computer modeling was used as a device in a case study for this report. To complete such modeling there must be enough data about the existing configuration and material composition of the building to create an accurate model. Once a baseline model is developed, design alternatives can be applied to learn how each affects the overall building performance and energy savings. Thermography can be used to analyze where energy leaks occur in a building prior to designing a repair, but it can also be used at the completion of construction to ensure the envelope is behaving as desired.

An energy audit is an analysis of a single building or campus, which indicates how and where energy consumption can be reduced to save on energy costs. There are three basic levels of an energy audit: preliminary audit, general audit, and comprehensive audit. A preliminary audit consists of short interviews with operations and maintenance personnel, a brief review of utility bills and other operating data, and a walk-through of the facility. Typically only one glaring area of inefficiency can be identified. Often a preliminary audit can be used to plan a more effective higher level audit.

A general audit consists of the collection of more detailed information about facility operation and performance, as well as a detailed evaluation of potential energy conservation measures. Utility bills from a one to three year period are collected to allow the auditor to evaluate the facility's energy/demand rate structures and energy usage profiles. Additional metering of specific systems is often performed to supplement utility data. In-depth interviews with facility operating personnel are conducted to provide a better understanding of major energy consuming systems as well as insight into variations in daily and annual energy consumption and demand.

A comprehensive audit analyzes the facility using its operating parameters. As with computer modeling, a detailed financial analysis is performed for each conservation measure based on detailed implementation cost estimates, site-specific operating cost savings, and the owner's

[79] Thermography measures surface temperatures by using infrared video and still cameras to see light that is in the heat spectrum. The images that are recorded on the video or film show the temperature variations of the building's skin and these are shown in different colors.

investment criteria in order to balance and justify the project implementation. Extensive attention is given to understanding not only the operating characteristics of all energy consuming systems, but also situations that cause load profile variations on both an annual and daily basis. Existing utility data is supplemented with sub-metering of major energy consuming systems and monitoring of system operating characteristics. Because most DoD buildings do not have sufficient metering to support a typical audit, an auditor can provide a meter to collect data for a certain period and extrapolate the results to provide some baseline energy consumption data for the building.

7.1.2 RENEWABLE ENERGY

EISA 2007 includes requirements to reduce the use of fossil fuels and incorporate solar hot water demand where feasible. While the act requires a 30% reduction of energy use by 2015, it also calls for 65% reduction of fossil fuel use by that same date and 100% reduction of fossil fuel use by 2030. This requires the implementation and use of alternative energy sources. To support that, Section 523 of EISA 2007 requires 30% of the hot water demand in new federal buildings (and major renovations) to be met with solar hot water equipment, provided it is life-cycle cost-effective.

With regard to fossil fuels, EISA 2007 states "buildings shall be designed so that the fossil fuel-generated energy consumption of the buildings is reduced, as compared with such energy consumption by a similar building in fiscal year 2003 (as measured by Commercial Buildings Energy Consumption Survey)" (Subtitle C, High-Performance Federal Buildings, Section 433, Federal Building Energy Efficiency Performance Standards). The table below shows the amount of fossil fuel reduction that is expected in federal buildings under Section 433 of EISA 2007.

Table 8: Fossil fuel reduction

Fiscal Year	Percentage Reduction
2010	55
2015	65
2020	80
2025	90
2030	100

Source: Subtitle C, High-Performance Federal Buildings, Section 433, Federal Building Energy Efficiency Performance Standards

These requirements mean that the DoD should be looking for alternative energy sources for their buildings, including historic properties. Energy sources such as wind and other alternatives that are located some distance from the building and are brought in using existing transmission lines would not have an adverse impact on the historic building. However, if the alternative energy source is located on the DoD installation there may be other cultural resource issues with the site, such as archaeology or cultural landscapes.

If alternative energy sources are to be placed adjacent to or on the historic building, this should be identified early in the project planning so it can be placed to minimize the effects on the historic architectural character. If a gable faces to the south and is at the back of a building, it could support the placement of an effective solar panel. If that same south-facing gable is on the primary elevation, a system that blends with the historic roof system could be installed, an alternative location could be chosen, or different energy source could be found.

When a project meets the requirements of EISA 2007, it is basically optimizing energy efficiency. As we have seen, this is but one aspect of sustainability. It is, however, critical to the goals of the federal government and therefore of primary interest in DoD historic preservation / sustainability projects. Working to meet commissioning by defining green goals and analyzing historic character-defining features and possible retrofits can support the preservation / sustainability planning process while developing documentation that can serve as a tool to complete the commissioning process. Certain features of historic buildings may aid in designing a system that can reduce energy consumption or support the use of alternative energy sources, but in order to take the best advantage of those features it is important to understand their architectural importance and how they can support the energy goals for the project.

As noted in Chapter 3, the guiding principles of the MOU that most affect historic buildings are: employ integrated design principles; optimize energy performance; and enhance IEQ. The primary elements of EISA 2007 that affect historic buildings include commissioning, energy efficiency and the use of alternative energy sources. If the concept of commissioning is used as outlined in this document, the project team will be using integrated design principals; i.e. considering site issues, sustainability and preservation early in the planning process and integrating them successfully into a final rehabilitation design that meets DoD sustainability goals and the Secretary's Standards. By using and enhancing the historic features that can support the energy goals, the project will be optimizing energy use and aiding the DoD in achieving the overall EISA 2007 goals for energy.

7.2 SUMMARY

Technology, preservation and the art of green architecture are always evolving. It is important to keep abreast of the advances and how they may affect or can best be used to retrofit a historic building with HVAC and other systems, as well as how the modern systems can take advantage of the elements that are extant in historic properties that may already support the green goals of the project.

8.0 CONCLUSION

What is already green in historic buildings? A variety of assumptions has been made when the question has been asked, with answers that range from "everything" to "nothing." This study has shown that historic buildings are better conceived of as being "shades" of green than as being green or not green. Several key points that emerged from this study are that, 1) historic and contemporary notions of sustainability should not be directly compared, 2) historic buildings were designed as "systems", 3) the systemic functions of historic buildings should be carefully studied and understood before energy efficiency and other sustainability improvement measures are taken, and 4) when the historic functions and systems of buildings are understood and recognized, modern improvements *can* be made to improve the energy efficiency and sustainability of historic buildings, and resource managers *can* meet both the requirements set out in energy policies and historic preservation policies.

Historic builders did not think in terms of "green" or "sustainable" construction. They did, however, attempt to mitigate the effects of climate and create the best possible IEQ with the technologies available to them at the time. They did so by designing buildings that functioned as a system in which ventilation; conduction, convection, and radiation; daylighting; orientation; shape; building materials; and some architectural style elements worked in concert. When we make changes to one of these parts of a historic building system, we potentially alter the other pieces. Understanding how the pieces work together can prevent us from making changes that negatively affect the overall sustainability of the building, and at the same time can help prevent us from negatively affecting the historic character of the building.

The Energy Model case study revealed that, using modern standards and use patterns, historic buildings are not necessarily energy efficient. Although many historic buildings may never reach an Energy Star rating, even when modifications that take into consideration the historic building system are made, the energy efficiency of these buildings can be dramatically improved. One of the easiest ways to do so, as the case study Energy Model indicated, was to replace old central heating and cooling system equipment, either with new localized or new central equipment. While energy efficiencies do pose particular challenges for historic buildings, the overall sustainability of these buildings should not be considered solely in terms of energy use—integrated design and IEQ principles may already be present in historic buildings and should be studied, understood, and used when making changes or alterations meant to meet sustainability policy requirements.

While the obvious green characteristic of historic buildings is their embodied energy, the other ways in which these buildings can be green should neither be ignored nor exaggerated in the attempt to green DoD facilities. The best way to ensure that the requirements to meet federal laws for energy efficiency, sustainability, and the preservation of historic resources are met is to understand the existing sustainable elements of historic buildings by conducting a thorough historic preservation and sustainability analysis prior to making alterations. Only by understanding the historic use, systems, and character-defining features of historic buildings can we be truly prepared to make them deeper shades of green.

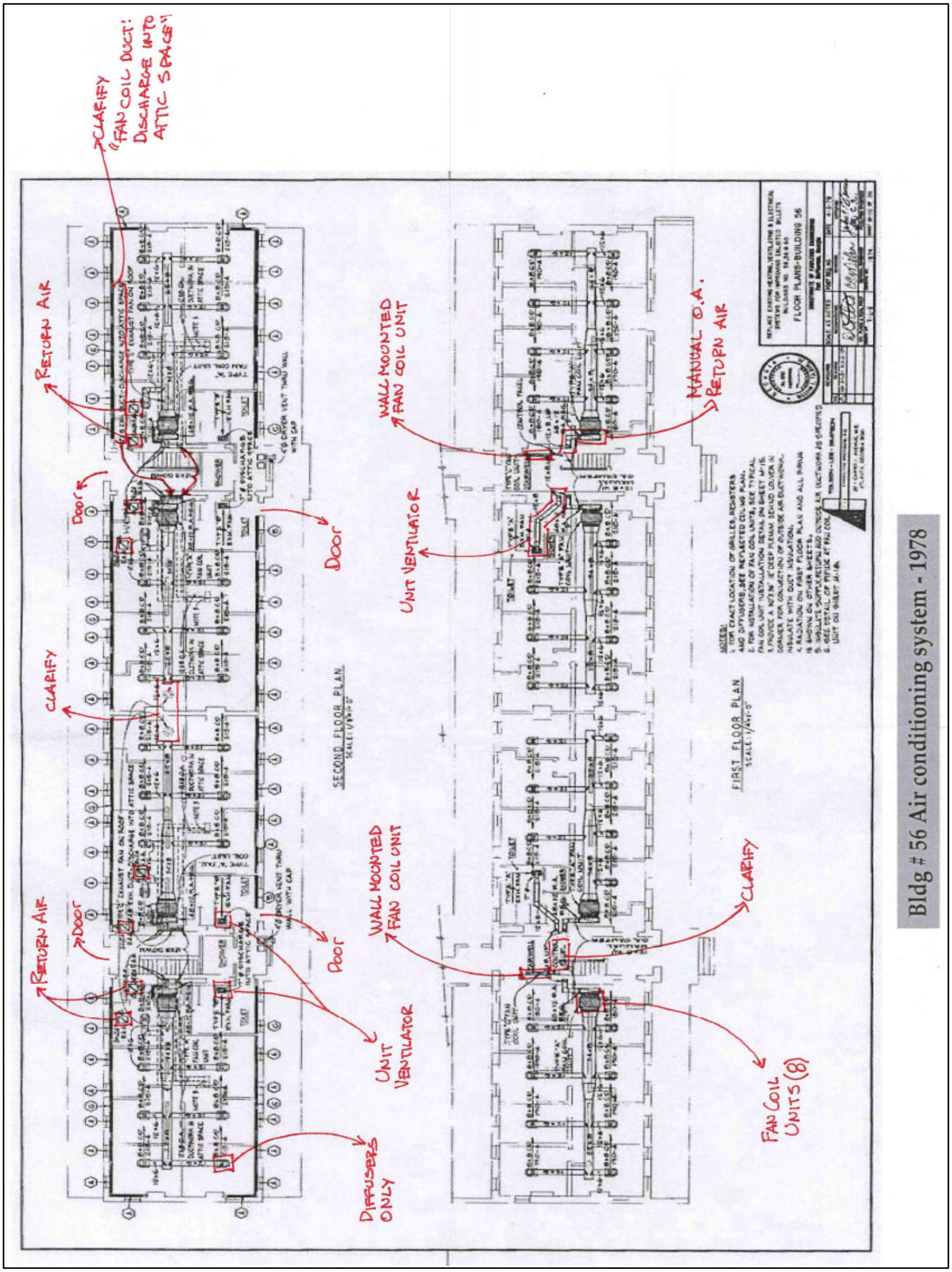
APPENDIX: SUPPLEMENTAL CASE STUDY INFORMATION

Contents:

Energy Modeling Assumptions Spreadsheet

Building Element	Assumption	Clarifications
Floor to Floor Height	First Floor : 14'-0"	
	Second Floor: 10'-0'	
Floor to Celing Height	First Floor : 12'-0"	
	Second Floor: 9'-0' <<< Unconditioned Attic Space	
Pitched Roof	25 Deg. Pitched Roof, 0.7' Overhang	
Roof Insulation	No Insulation Used	
Roof Surfaces	Construction: Wood Standard Frame	
	Ext. Finish & Color: Clay Tile, Orange Medium	
Exterior Walls	1.7' Brick (red Masonry).	
	No exterior board Insulation, No furred insulation	
Ground Floor	Exposure: Over Crawl Space	
	Construction: 1 in. Plywood Underlayment	
Ceilings	Lay-in Acoustic Tile	
Inerior Wall Type	Wood Frame, No Insulation.	
Exterior Doors	Opaque, Wood Solid Core Flush, 1.75" Frame	
	A: Height: 7'-0" Width: 3'-0"	
	B: Height: 7'-0" Width: 4.88'	
Exterior Windows Type	Single Clear 1/8"	
	Frame: Wood without Thermal break, Operable	
	Width: 3.25' Height: 6' Sill: 2'	
	Width: 4.88' Height: 6' Sill: 2'	
Building Operation Schedule	Low Use, Monday though Friday, 8AM to 5PM	
Lighting Power Density	LPD: 2.75 W/sqft - Based on "Code for Energy Conservation" (1977)	
HVAC System Definitions	Cooling Source: DX Coils	
	Heating Source: Hot Water Coils	
	Hot Water Source: Hot Water Loop	
	System Type: Packaged Multizone with HW heat	
	Return Air Path: Plenum	
Seasonal Thermostat Setpoints:	Occupied: Cool=76 deg Heat= 70 deg	
	Unoccupied: Cool=76 deg Heat= 70 deg	
Design temperatures	Cooling Temp: Indoor: 75 Deg. Supply: 55 Deg.	
	Heating Temp: Indoor: 72 Deg. Supply: 90 Deg.	
Air Flows	Minimum Design Flow: 0.50 cfm/ft2	
	VAV Minimum Flow: 100%	
Packaged HVAC Equipment	Overall Size: Autosize	
	Typical Unit Size: 135-240 kBtuh or 11.25-20 tons	
	Efficiency: EER 8.500	
	Allow Crankcase Heating - NO	
HVAC System Fans	Single Fan Forward Curved Centrifugal w/ Inlet Vanes	
	Power & Motor Efficiency: 2.50 in. WG, High Efficiency	
HVAC System Fan Schedules	Operate 1 hour before open and 1 hour after close	
	Cycle Fans at Night: Minimum OA	
	Fan "On" Mode: Intermittent	
HVAC Zone Heating, Vent and Economizers	No Economizer	
	No Baseboards	
HVAC System Hot/Cold Deck Rests	No Hot / Cold Deck reset	
Domestic Hot Water Equipment	Storage Tank: Capacity: 41 gallons, No Insulation (R=0)	
	Water Inlet Temperature: Ground Temperature	
	No recirculation	
Exhaust Fans	0.50 in. WG, 100 cfm	
	Efficiency: Standard	
Roof Dormers	Considered Vents	

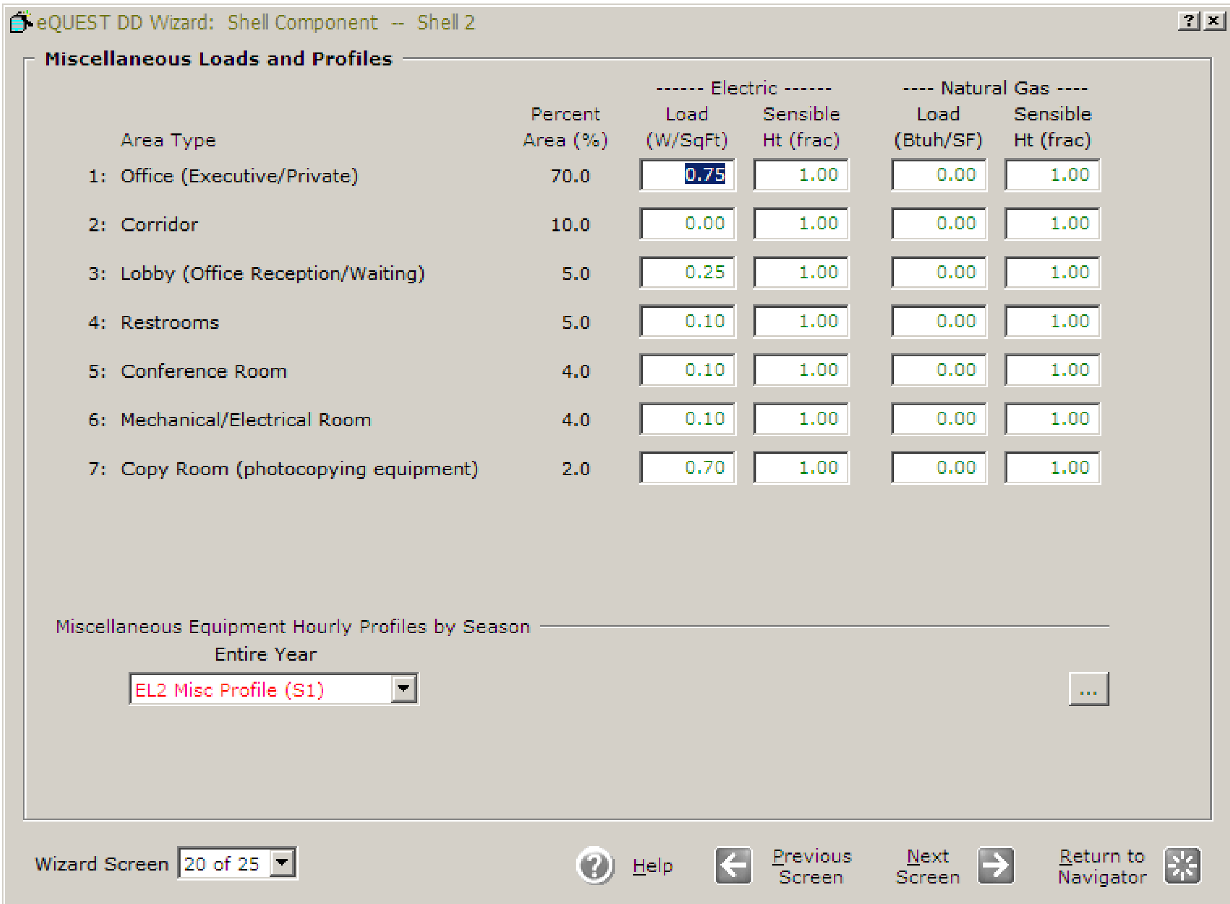
Energy Modeling Assumptions Floor Plan



Bldg # 56 Air conditioning system - 1978

<u>Equipment Power Density Assumptions: eQUEST Default Parameters for Office Buildings</u>

Equipment power densities are treated as constants throughout all models of the study. Below is a screen-capture of eQuest default densities for office building equipment by activity area. These defaults were used for all simulations, as well all default simulation usage schedules/profiles.


eQUEST DD Wizard: Shell Component -- Shell 2

Miscellaneous Loads and Profiles

	Area Type	Percent Area (%)	Electric Load (W/SqFt)	Electric Sensible Ht (frac)	Natural Gas Load (Btuh/SF)	Natural Gas Sensible Ht (frac)
1:	Office (Executive/Private)	70.0	0.75	1.00	0.00	1.00
2:	Corridor	10.0	0.00	1.00	0.00	1.00
3:	Lobby (Office Reception/Waiting)	5.0	0.25	1.00	0.00	1.00
4:	Restrooms	5.0	0.10	1.00	0.00	1.00
5:	Conference Room	4.0	0.10	1.00	0.00	1.00
6:	Mechanical/Electrical Room	4.0	0.10	1.00	0.00	1.00
7:	Copy Room (photocopying equipment)	2.0	0.70	1.00	0.00	1.00

Miscellaneous Equipment Hourly Profiles by Season

Entire Year

EL2 Misc Profile (S1)

Wizard Screen 20 of 25

Help | Previous Screen | Next Screen | Return to Navigator

Gas Consumption does not include Campus Loop heating energy*

Due to variations in Elevation across all five U.S. climate zones a constant Elevation of 1010' was used

Note: 100,000 Btu's = 1 Therm and 1 kWh = 3,413 Btu's

Energy Efficiency Measures (EEM)	E/W Color Key	N/S Color Key
1 - Double Pane Windows	Climate Zone 1	Climate Zone 1
2 - R-38 Roof Insulation	Climate Zone 2	Climate Zone 2
3 - Reduced Lighting Power	Climate Zone 3	Climate Zone 3
4 - R-19 Wall Insulation	Climate Zone 4	Climate Zone 4
5 - Combo	Climate Zone 5	Climate Zone 5

BUILDING AREA	16,164.00
CBECS Offices	92.9
CBECS Residential	48.5

					OFFICE BUILDING TYPE			RESIDENTIAL BUILDING TYPE		
Iteration		**Electric Consumption (kWh/yr)**	**Gas Consumption* (Therm/yr)**	**Campus Loop Heat (MBtu/yr)**	**Total Consumption (kBtu/sf/yr)**	**Energy Savings From Baseline**	**Energy Savings From CBECS**	**Residential Consumption (52.2% * kBtu/sf/yr)**	**Energy Savings From Baseline**	**Energy Savings From CBECS**
EAST / WEST ORIENTATION OUTPUT										
C1-1	Baseline	381,910.0	292.0	2,006.0	206.55	N/A	-122%	107.82	N/A	-122%
2	EEM-1	361,303.0	292.0	1,878.0	194.28	6%	-109%	101.41	6%	-109%
3	EEM-2	382,609.0	291.0	1,942.0	202.73	2%	-118%	105.83	2%	-118%
4	EEM-3	350,291.0	292.0	2,066.0	203.58	1%	-119%	106.27	1%	-119%
5	EEM-4	372,452.0	291.0	1,587.0	178.62	14%	-92%	93.24	14%	-92%
6	EEM-5	316,599.0	290.0	1,433.0	157.30	24%	-69%	82.11	24%	-69%
C2-7	Baseline	412,182.0	277.0	1,851.0	203.26	N/A	-119%	106.10	N/A	-119%
8	EEM-1	386,002.0	277.0	1,732.0	190.37	6%	-105%	99.37	6%	-105%
9	EEM-2	412,891.0	277.0	1,817.0	201.31	1%	-117%	105.08	1%	-117%
10	EEM-3	378,744.0	277.0	1,902.0	199.35	2%	-115%	104.06	2%	-115%
11	EEM-4	391,704.0	276.0	1,489.0	176.53	13%	-90%	92.15	13%	-90%
12	EEM-5	327,455.0	276.0	1,367.0	155.42	24%	-67%	81.13	24%	-67%
C3-13	Baseline	345,784.0	262.0	1,235.0	151.04	N/A	-63%	78.84	N/A	-63%
14	EEM-1	327,375.0	261.0	1,148.0	141.76	6%	-53%	74.00	6%	-53%
15	EEM-2	345,838.0	261.0	1,198.0	148.75	2%	-60%	77.65	2%	-60%
16	EEM-3	314,258.0	262.0	1,283.0	147.35	2%	-59%	76.92	2%	-59%
17	EEM-4	346,099.0	260.0	962.0	134.20	11%	-44%	70.05	11%	-44%
18	EEM-5	292,535.0	259.0	860.0	116.58	23%	-25%	60.85	23%	-25%
C4-19	Baseline	357,910.0	249.0	1,110.0	145.78	N/A	-57%	76.10	N/A	-57%
20	EEM-1	338,510.0	249.0	1,038.0	137.23	6%	-48%	71.64	6%	-48%
21	EEM-2	357,933.0	249.0	1,085.0	144.24	1%	-55%	75.29	1%	-55%
22	EEM-3	324,858.0	249.0	1,154.0	141.53	3%	-52%	73.88	3%	-52%
23	EEM-4	350,051.0	248.0	879.0	129.83	11%	-40%	67.77	11%	-40%
24	EEM-5	294,480.0	247.0	801.0	113.26	22%	-22%	59.12	22%	-22%
C5-25	Baseline	320,105.0	220.0	476.0	98.40	N/A	-6%	51.36	N/A	-6%
26	EEM-1	304,489.0	220.0	443.0	93.06	5%	0%	48.58	5%	0%
27	EEM-2	320,134.0	220.0	463.0	97.60	1%	-5%	50.95	1%	-5%
28	EEM-3	287,098.0	220.0	507.0	93.35	5%	0%	48.73	5%	0%
29	EEM-4	316,687.0	218.0	379.0	91.66	7%	1%	47.85	7%	1%
30	EEM-5	266,504.0	218.0	346.0	79.03	20%	15%	41.25	20%	15%
NORTH / SOUTH ORIENTATION OUTPUT										
C1-31	Baseline	402,321.0	291.0	1,963.0	208.19	N/A	-124%	108.68	N/A	-124%
32	EEM-1	380,560.0	291.0	1,836.0	195.74	6%	-111%	102.18	6%	-111%
33	EEM-2	403,264.0	291.0	1,898.0	204.37	2%	-120%	106.68	2%	-120%
34	EEM-3	371,781.0	291.0	2,022.0	205.39	1%	-121%	107.22	1%	-121%
35	EEM-4	392,333.0	290.0	1,547.0	180.34	13%	-94%	94.14	13%	-94%
36	EEM-5	334,787.0	289.0	1,390.0	158.47	24%	-71%	82.72	24%	-71%
C2-37	Baseline	422,830.0	276.0	1,837.0	204.63	N/A	-120%	106.82	N/A	-120%
38	EEM-1	396,379.0	276.0	1,716.0	191.56	6%	-106%	100.00	6%	-106%
39	EEM-2	423,510.0	276.0	1,802.0	202.61	1%	-118%	105.76	1%	-118%
40	EEM-3	391,576.0	276.0	1,886.0	201.07	2%	-116%	104.96	2%	-116%
41	EEM-4	404,443.0	275.0	1,472.0	178.17	13%	-92%	93.00	13%	-92%
42	EEM-5	341,579.0	275.0	1,348.0	157.22	23%	-69%	82.07	23%	-69%
C3-43	Baseline	359,387.0	261.0	1,194.0	151.37	N/A	-63%	79.01	N/A	-63%
44	EEM-1	341,895.0	260.0	1,107.0	142.28	6%	-53%	74.27	6%	-53%
45	EEM-2	359,886.0	260.0	1,158.0	149.24	1%	-61%	77.90	1%	-61%
46	EEM-3	328,959.0	261.0	1,237.0	147.60	2%	-59%	77.05	2%	-59%
47	EEM-4	363,696.0	259.0	929.0	135.87	10%	-46%	70.92	10%	-46%
48	EEM-5	310,270.0	258.0	827.0	118.27	22%	-27%	61.74	22%	-27%
C4-49	Baseline	363,369.0	248.0	1,084.0	145.32	N/A	-56%	75.86	N/A	-56%
50	EEM-1	345,429.0	248.0	1,013.0	137.14	6%	-48%	71.59	6%	-48%
51	EEM-2	363,957.0	248.0	1,061.0	144.02	1%	-55%	75.18	1%	-55%
52	EEM-3	331,987.0	248.0	1,126.0	141.29	3%	-52%	73.76	3%	-52%
53	EEM-4	361,876.0	247.0	853.0	130.71	10%	-41%	68.23	10%	-41%
54	EEM-5	308,313.0	247.0	777.0	114.70	21%	-23%	59.87	21%	-23%
C5-55	Baseline	326,118.0	219.0	467.0	99.11	N/A	-7%	51.73	N/A	-7%
56	EEM-1	310,391.0	219.0	434.0	93.74	5%	-1%	48.93	5%	-1%
57	EEM-2	326,112.0	219.0	453.0	98.24	1%	-6%	51.28	1%	-6%
58	EEM-3	293,491.0	219.0	496.0	94.01	5%	-1%	49.07	5%	-1%
59	EEM-4	323,838.0	218.0	369.0	92.56	7%	0%	48.31	7%	0%
60	EEM-5	272,897.0	217.0	336.0	79.75	20%	14%	41.63	20%	14%

Gas Consumption does not include Campus Loop heating energy*
Due to variations in Elevation across all five U.S. climate zones a constant Elevation of 1010' was used
Additionally, due to variations in utility costs all climate zones utility rates are generalized (see explanation in project narrative)
***Note:** 100,000 Btu's = 1 Therm and 1 kWh = 3,413 Btu's*

Energy Efficiency Measures (EEM)
1 - Double Pane Windows
2 - R-38 Roof Insulation
3 - Reduced Lighting Power
4 - R-19 Wall Insulation
5 - Combo of Envelope Modifications
6 - Localized HVAC
7 - Combo w/ All EEMs (HVAC & Envelope)

E/W Color Key	N/S Color Key
Climate Zone 1	Climate Zone 1
Climate Zone 2	Climate Zone 2
Climate Zone 3	Climate Zone 3
Climate Zone 4	Climate Zone 4
Climate Zone 5	Climate Zone 5

BUILDING AREA	16,164.00
CBECS Offices	92.9
CBECS Residential	48.5
Residential Multiplier	52.2%

							OFFICE BUILDING BUILDING TYPE					RESIDENTIAL BUILDING TYPE				
Iteration		Electric Consumption (kWh/yr)	Annual Electricity Cost ($0.1108/kWh)	Gas Consumption* (Therm/yr)	Campus Loop Heat (MBtu/yr)	Annual Gas Cost ($1.1760/Therm)	Annual Total Utility Cost	Annual Cost Savings From Baseline	Total Consumption (kBtu/sf/yr)	Energy Savings From Baseline	Energy Savings From CBECS	Annual Total Utility Cost	Annual Cost Savings From Baseline	Residential Consumption (52.2% * kBtu/sf/yr)	Energy Savings From Baseline	Energy Savings From CBECS
EAST / WEST ORIENTATION OUTPUT																
C1-1	Baseline	381,910.0	$ 42,315.63	292.0	2,006.0	$ 23,933.95	$ 66,249.58	N/A	206.55	N/A	-122%	$ 34,586.70	N/A	107.82	N/A	-122%
2	EEM-1	361,303.0	$ 40,032.37	292.0	1,878.0	$ 22,428.67	$ 62,461.04	$ 3,788.54	194.28	6%	-109%	$ 32,608.83	$ 1,977.87	101.41	6%	-109%
3	EEM-2	382,609.0	$ 42,393.08	291.0	1,942.0	$ 23,180.14	$ 65,573.21	$ 676.37	202.73	2%	-118%	$ 34,233.59	$ 353.11	105.83	2%	-118%
4	EEM-3	350,291.0	$ 38,812.24	292.0	2,066.0	$ 24,639.55	$ 63,451.79	$ 2,797.79	203.58	1%	-119%	$ 33,126.07	$ 1,460.63	106.27	1%	-119%
5	EEM-4	372,452.0	$ 41,267.68	291.0	1,587.0	$ 19,005.34	$ 60,273.02	$ 5,976.56	178.62	14%	-92%	$ 31,466.54	$ 3,120.16	93.24	14%	-92%
6	EEM-5	316,599.0	$ 35,079.17	290.0	1,433.0	$ 17,193.12	$ 52,272.29	$ 13,977.29	157.30	24%	-69%	$ 27,289.62	$ 7,297.08	82.11	24%	-69%
C1.EW.HVAC	EEM-6	190,238.0	$ 21,078.37	16,164.0	0.0	$ 19,008.86	$ 40,087.23	$ 26,162.35	58.76	72%	37%	$ 20,928.21	$ 13,658.49	30.67	72%	37%
C1.EW.HVAC	EEM-7	155,075.0	$ 17,182.31	12,202.0	0.0	$ 14,349.55	$ 31,531.86	$ 34,717.72	47.78	77%	49%	$ 16,461.74	$ 18,124.97	24.94	77%	49%
C2-7	Baseline	412,182.0	$ 45,669.77	277.0	1,851.0	$ 22,093.51	$ 67,763.28	N/A	203.26	N/A	-119%	$ 35,376.95	N/A	106.10	N/A	-119%
8	EEM-1	386,002.0	$ 42,769.02	277.0	1,732.0	$ 20,694.07	$ 63,463.09	$ 4,300.18	190.37	6%	-105%	$ 33,131.97	$ 2,244.98	99.37	6%	-105%
9	EEM-2	412,891.0	$ 45,748.32	277.0	1,817.0	$ 21,693.67	$ 67,441.99	$ 321.28	201.31	1%	-117%	$ 35,209.22	$ 167.73	105.08	1%	-117%
10	EEM-3	378,744.0	$ 41,964.84	277.0	1,902.0	$ 22,693.27	$ 64,658.11	$ 3,105.17	199.35	2%	-115%	$ 33,755.85	$ 1,621.11	104.06	2%	-115%
11	EEM-4	391,704.0	$ 43,400.80	276.0	1,489.0	$ 17,835.22	$ 61,236.02	$ 6,527.26	176.53	13%	-90%	$ 31,969.29	$ 3,407.66	92.15	13%	-90%
12	EEM-5	327,455.0	$ 36,282.01	276.0	1,367.0	$ 16,400.50	$ 52,682.51	$ 15,080.77	155.42	24%	-67%	$ 27,503.79	$ 7,873.17	81.13	24%	-67%
C2.EW.HVAC	EEM-6	206,677.0	$ 22,899.81	14,658.0	0.0	$ 17,237.81	$ 40,137.62	$ 27,625.66	134.32	34%	-45%	$ 20,954.52	$ 14,422.44	70.12	34%	-45%
C2.EW.HVAC	EEM-7	162,656.0	$ 18,022.28	11,251.0	0.0	$ 13,231.18	$ 31,253.46	$ 36,509.82	103.95	49%	-12%	$ 16,316.39	$ 19,060.56	54.26	49%	-12%
C3-13	Baseline	345,784.0	$ 38,312.87	262.0	1,235.0	$ 14,831.71	$ 53,144.58	N/A	151.04	N/A	-63%	$ 27,745.02	N/A	78.84	N/A	-63%
14	EEM-1	327,375.0	$ 36,273.15	261.0	1,148.0	$ 13,807.42	$ 50,080.57	$ 3,064.01	141.76	6%	-53%	$ 26,145.40	$ 1,599.62	74.00	6%	-53%
15	EEM-2	345,838.0	$ 38,318.85	261.0	1,198.0	$ 14,395.42	$ 52,714.27	$ 430.31	148.75	2%	-60%	$ 27,520.37	$ 224.65	77.65	2%	-60%
16	EEM-3	314,258.0	$ 34,819.79	262.0	1,283.0	$ 15,396.19	$ 50,215.98	$ 2,928.60	147.35	2%	-59%	$ 26,216.09	$ 1,528.93	76.92	2%	-59%
17	EEM-4	346,099.0	$ 38,347.77	260.0	962.0	$ 11,618.88	$ 49,966.65	$ 3,177.93	134.20	11%	-44%	$ 26,085.93	$ 1,659.09	70.05	11%	-44%
18	EEM-5	292,535.0	$ 32,412.88	259.0	860.0	$ 10,418.18	$ 42,831.06	$ 10,313.52	116.58	23%	-25%	$ 22,360.67	$ 5,384.34	60.85	23%	-25%
C3.EW.HVAC	EEM-6	198,578.0	$ 22,002.44	8,815.0	0.0	$ 10,366.44	$ 32,368.88	$ 20,775.70	96.46	36%	-4%	$ 16,898.72	$ 10,846.30	50.35	36%	-4%
C3.EW.HVAC	EEM-7	160,896.0	$ 17,827.28	6,586.0	0.0	$ 7,745.14	$ 25,572.41	$ 27,572.17	74.72	51%	20%	$ 13,350.51	$ 14,394.51	39.00	51%	20%
C4-19	Baseline	357,910.0	$ 39,656.43	249.0	1,110.0	$ 13,346.42	$ 53,002.85	N/A	145.78	N/A	-57%	$ 27,671.03	N/A	76.10	N/A	-57%
20	EEM-1	338,510.0	$ 37,506.91	249.0	1,038.0	$ 12,499.70	$ 50,006.61	$ 2,996.24	137.23	6%	-48%	$ 26,106.79	$ 1,564.24	71.64	6%	-48%
21	EEM-2	357,933.0	$ 39,658.98	249.0	1,085.0	$ 13,052.42	$ 52,711.40	$ 291.45	144.24	1%	-55%	$ 27,518.87	$ 152.16	75.29	1%	-55%
22	EEM-3	324,858.0	$ 35,994.27	249.0	1,154.0	$ 13,863.86	$ 49,858.13	$ 3,144.72	141.53	3%	-52%	$ 26,029.27	$ 1,641.75	73.88	3%	-52%
23	EEM-4	350,051.0	$ 38,785.65	248.0	879.0	$ 10,628.69	$ 49,414.34	$ 3,588.51	129.83	11%	-40%	$ 25,797.58	$ 1,873.44	67.77	11%	-40%
24	EEM-5	294,480.0	$ 32,628.38	247.0	801.0	$ 9,710.23	$ 42,338.62	$ 10,664.24	113.26	22%	-22%	$ 22,103.58	$ 5,567.44	59.12	22%	-22%
C4.EW.HVAC	EEM-6	204,435.0	$ 22,651.40	6,951.0	0.0	$ 8,174.38	$ 30,825.77	$ 22,177.08	86.17	41%	7%	$ 16,093.11	$ 11,577.91	44.98	41%	7%
C4.EW.HVAC	EEM-7	162,057.0	$ 17,955.92	5,355.0	0.0	$ 6,297.48	$ 24,253.40	$ 28,749.46	67.35	54%	28%	$ 12,661.89	$ 15,009.13	35.16	54%	28%
C5-25	Baseline	320,105.0	$ 35,467.63	220.0	476.0	$ 5,856.48	$ 41,324.11	N/A	98.40	N/A	-6%	$ 21,573.95	N/A	51.36	N/A	-6%
26	EEM-1	304,489.0	$ 33,737.38	220.0	443.0	$ 5,468.40	$ 39,205.78	$ 2,118.33	93.06	5%	0%	$ 20,468.03	$ 1,105.91	48.58	5%	0%
27	EEM-2	320,134.0	$ 35,470.85	220.0	463.0	$ 5,703.60	$ 41,174.45	$ 149.67	97.60	1%	-5%	$ 21,495.81	$ 78.14	50.95	1%	-5%
28	EEM-3	287,098.0	$ 31,810.46	220.0	507.0	$ 6,221.04	$ 38,031.50	$ 3,292.62	93.35	5%	0%	$ 19,854.98	$ 1,718.97	48.73	5%	0%
29	EEM-4	316,687.0	$ 35,088.92	218.0	379.0	$ 4,713.41	$ 39,802.33	$ 1,521.79	91.66	7%	1%	$ 20,779.47	$ 794.47	47.85	7%	1%
30	EEM-5	266,504.0	$ 29,528.64	218.0	346.0	$ 4,325.33	$ 33,853.97	$ 7,470.14	79.03	20%	15%	$ 17,674.03	$ 3,899.91	41.25	20%	15%
C5.EW.HVAC	EEM-6	226,177.0	$ 25,060.41	1,778.0	0.0	$ 2,090.93	$ 27,151.34	$ 14,172.77	58.76	40%	37%	$ 14,174.81	$ 7,399.13	30.67	40%	37%
C5.EW.HVAC	EEM-7	178,407.0	$ 19,767.50	1,634.0	0.0	$ 1,921.58	$ 21,689.08	$ 19,635.03	47.78	51%	49%	$ 11,323.15	$ 10,250.80	24.94	51%	49%
NORTH / SOUTH ORIENTATION OUTPUT																
C1-31	Baseline	402,321.0	$ 44,577.17	291.0	1,963.0	$ 23,427.10	$ 68,004.26	N/A	208.19	N/A	-124%	$ 35,502.76	N/A	108.68	N/A	-124%
32	EEM-1	380,560.0	$ 42,166.05	291.0	1,836.0	$ 21,933.58	$ 64,099.62	$ 3,904.64	195.74	6%	-111%	$ 33,464.28	$ 2,038.48	102.18	6%	-111%
33	EEM-2	403,264.0	$ 44,681.65	291.0	1,898.0	$ 22,662.70	$ 67,344.35	$ 659.92	204.37	2%	-120%	$ 35,158.24	$ 344.52	106.68	2%	-120%
34	EEM-3	371,781.0	$ 41,193.33	291.0	2,022.0	$ 24,120.94	$ 65,314.27	$ 2,689.99	205.39	1%	-121%	$ 34,098.41	$ 1,404.36	107.22	1%	-121%
35	EEM-4	392,333.0	$ 43,470.50	290.0	1,547.0	$ 18,533.76	$ 62,004.26	$ 6,000.01	180.34	13%	-94%	$ 32,370.36	$ 3,132.40	94.14	13%	-94%
36	EEM-5	334,787.0	$ 37,094.40	289.0	1,390.0	$ 16,686.26	$ 53,780.66	$ 14,223.60	158.47	24%	-71%	$ 28,077.10	$ 7,425.67	82.72	24%	-71%
C1.NS.HVAC	EEM-6	202,641.0	$ 22,452.62	16,282.0	0.0	$ 19,147.63	$ 41,600.25	$ 26,404.01	143.52	31%	-54%	$ 21,718.11	$ 13,784.65	74.92	-45%	-54%
C1.NS.HVAC	EEM-7	166,497.0	$ 18,447.87	12,152.0	0.0	$ 14,290.75	$ 32,738.62	$ 35,265.64	110.33	47%	-19%	$ 17,091.74	$ 18,411.02	57.59	-11%	-19%
C2-37	Baseline	422,830.0	$ 46,849.56	276.0	1,837.0	$ 21,927.70	$ 68,777.26	N/A	204.63	N/A	-120%	$ 35,906.32	N/A	106.82	N/A	-120%
38	EEM-1	396,379.0	$ 43,918.79	276.0	1,716.0	$ 20,504.74	$ 64,423.53	$ 4,353.73	191.56	6%	-106%	$ 33,633.38	$ 2,272.94	100.00	6%	-106%
39	EEM-2	423,510.0	$ 46,924.91	276.0	1,802.0	$ 21,516.10	$ 68,441.00	$ 336.26	202.61	1%	-118%	$ 35,730.77	$ 175.55	105.76	1%	-118%
40	EEM-3	391,576.0	$ 43,386.62	276.0	1,886.0	$ 22,503.94	$ 65,890.56	$ 2,886.70	201.07	2%	-116%	$ 34,399.27	$ 1,507.05	104.96	2%	-116%
41	EEM-4	404,443.0	$ 44,812.28	275.0	1,472.0	$ 17,634.12	$ 62,446.40	$ 6,330.86	178.17	13%	-92%	$ 32,601.19	$ 3,305.13	93.00	13%	-92%
42	EEM-5	341,579.0	$ 37,846.95	275.0	1,348.0	$ 16,175.88	$ 54,022.83	$ 14,754.43	157.22	23%	-69%	$ 28,203.52	$ 7,702.80	82.07	23%	-69%
C2.NS.HVAC	EEM-6	215,382.0	$ 23,864.33	14,843.0	0.0	$ 17,455.37	$ 41,319.69	$ 27,457.57	137.31	33%	-48%	$ 21,571.64	$ 14,334.68	71.67	33%	-48%
C2.NS.HVAC	EEM-7	172,126.0	$ 19,071.56	11,351.0	0.0	$ 13,348.78	$ 32,420.34	$ 36,356.92	106.57	48%	-15%	$ 16,925.58	$ 18,980.74	55.63	48%	-15%
C3-43	Baseline	359,387.0	$ 39,820.08	261.0	1,194.0	$ 14,348.38	$ 54,168.46	N/A	151.37	N/A	-63%	$ 28,279.55	N/A	79.01	N/A	-63%
44	EEM-1	341,895.0	$ 37,881.97	260.0	1,107.0	$ 13,324.08	$ 51,206.05	$ 2,962.41	142.28	6%	-53%	$ 26,732.97	$ 1,546.58	74.27	6%	-53%
45	EEM-2	359,886.0	$ 39,875.37	260.0	1,158.0	$ 13,923.84	$ 53,799.21	$ 369.25	149.24	1%	-61%	$ 28,086.78	$ 192.77	77.90	1%	-61%
46	EEM-3	328,959.0	$ 36,448.66	261.0	1,237.0	$ 14,854.06	$ 51,302.71	$ 2,865.74	147.60	2%	-59%	$ 26,783.44	$ 1,496.11	77.05	2%	-59%
47	EEM-4	363,696.0	$ 40,297.52	259.0	929.0	$ 11,229.62	$ 51,527.14	$ 2,641.31	135.87	10%	-46%	$ 26,900.61	$ 1,378.94	70.92	10%	-46%
48	EEM-5	310,270.0	$ 34,377.92	258.0	827.0	$ 10,028.93	$ 44,406.84	$ 9,761.61	118.27	22%	-27%	$ 23,183.34	$ 5,096.21	61.74	22%	-27%
C3.NS.HVAC	EEM-6	212,557.0	$ 23,551.32	8,719.0	0.0	$ 10,253.54	$ 33,804.86	$ 20,363.60	98.82	53%	-6%	$ 17,648.39	$ 10,631.16	51.59	0%	-6%
C3.NS.HVAC	EEM-7	173,417.0	$ 19,214.60	6,411.0	0.0	$ 7,539.34	$ 26,753.94	$ 27,414.52	76.28	63%	18%	$ 13,967.34	$ 14,312.21	39.82	23%	18%
C4-49	Baseline	363,369.0	$ 40,261.29	248.0	1,084.0	$ 13,039.49	$ 53,300.77	N/A	145.32	N/A	-56%	$ 27,826.56	N/A	75.86	N/A	-56%
50	EEM-1	345,429.0	$ 38,273.53	248.0	1,013.0	$ 12,204.53	$ 50,478.06	$ 2,822.71	137.14	6%	-48%	$ 26,352.92	$ 1,473.64	71.59	6%	-48%
51	EEM-2	363,957.0	$ 40,326.44	248.0	1,061.0	$ 12,769.01	$ 53,095.44	$ 205.33	144.02	1%	-55%	$ 27,719.37	$ 107.20	75.18	1%	-55%
52	EEM-3	331,987.0	$ 36,784.16	248.0	1,126.0	$ 13,533.41	$ 50,317.57	$ 2,983.21	141.29	3%	-52%	$ 26,269.13	$ 1,557.43	73.76	3%	-52%
53	EEM-4	361,876.0	$ 40,095.86	247.0	853.0	$ 10,321.75	$ 50,417.61	$ 2,883.16	130.71	10%	-41%	$ 26,321.36	$ 1,505.20	68.23	10%	-41%
54	EEM-5	308,313.0	$ 34,161.08	247.0	777.0	$ 9,427.99	$ 43,589.07	$ 9,711.70	114.70	21%	-23%	$ 22,756.40	$ 5,070.16	59.87	21%	-23%
C4.NS.HVAC	EEM-6	212,462.0	$ 23,540.79	6,910.0	0.0	$ 8,126.16	$ 31,666.95	$ 21,633.82	87.61	40%	6%	$ 16,532.26	$ 11,294.30	45.73	40%	6%
C4.NS.HVAC	EEM-7	171,355.0	$ 18,986.13	5,291.0	0.0	$ 6,222.22	$ 25,208.35	$ 28,092.42	68.91	53%	26%	$ 13,160.44	$ 14,666.12	35.97	53%	26%
C5-55	Baseline	326,118.0	$ 36,133.87	219.0	467.0	$ 5,749.46	$ 41,883.34	N/A	99.11	N/A	-7%	$ 21,865.90	N/A	51.73	N/A	-7%
56	EEM-1	310,391.0	$ 34,391.32	219.0	434.0	$ 5,361.38	$ 39,752.71	$ 2,130.63	93.74	5%	-1%	$ 20,753.57	$ 1,112.33	48.93	5%	-1%
57	EEM-2	326,112.0	$ 36,133.21	219.0	453.0	$ 5,584.82	$ 41,718.03	$ 165.30	98.24	1%	-6%	$ 21,779.60	$ 86.30	51.28	1%	-6%
58	EEM-3	293,491.0	$ 32,518.80	219.0	496.0	$ 6,090.50	$ 38,609.31	$ 3,274.03	94.01	5%	-1%	$ 20,156.63	$ 1,709.26	49.07	5%	-1%
59	EEM-4	323,838.0	$ 35,881.25	218.0	369.0	$ 4,595.81	$ 40,477.06	$ 1,406.28	92.56	7%	0%	$ 21,131.73	$ 734.17	48.31	7%	0%
60	EEM-5	272,897.0	$ 30,236.99	217.0	336.0	$ 4,206.55	$ 34,443.54	$ 7,439.80	79.75	20%	14%	$ 17,981.83	$ 3,884.07	41.63	20%	14%
C5.NS.HVAC	EEM-6	234,393.0	$ 25,970.74	1,766.0	0.0	$ 2,076.82	$ 28,047.56	$ 13,835.78	60.42	39%	35%	$ 14,642.70	$ 7,223.20	31.54	39%	35%
C5.NS.HVAC	EEM-7	184,830.0	$ 20,479.16	1,621.0	0.0	$ 1,906.30	$ 22,385.46	$ 19,497.88	49.05	51%	47%	$ 11,686.70	$ 10,179.19	25.61	51%	47%

eQUEST Energy Simulation Schedules

Schedule Properties — Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: EL1 Bldg Occup WD — Type: Fraction
Day Schedule Name: EL1 Bldg Occup WD — Type: Fraction

Hourly Values

Mdnt - 1:	0.0000 ratio	8-9 am:	0.6750 ratio	4-5 pm:	0.5265 ratio
1-2 am:	0.0000 ratio	9-10 am:	0.6750 ratio	5-6 pm:	0.2228 ratio
2-3 am:	0.0000 ratio	10-11 am:	0.6750 ratio	6-7 pm:	0.0742 ratio
3-4 am:	0.0000 ratio	11-noon:	0.3780 ratio	7-8 pm:	0.0742 ratio
4-5 am:	0.0000 ratio	noon-1:	0.3780 ratio	8-9 pm:	0.0742 ratio
5-6 am:	0.0000 ratio	1-2 pm:	0.6750 ratio	9-10 pm:	0.0742 ratio
6-7 am:	0.0742 ratio	2-3 pm:	0.6750 ratio	10-11 pm:	0.0000 ratio
7-8 am:	0.5265 ratio	3-4 pm:	0.6750 ratio	11-Mdnt:	0.0000 ratio

Typical Office Occupancy

Schedule Properties — Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: EL1 Bldg InsLt WD — Type: Fraction
Day Schedule Name: EL1 Bldg InsLt WD — Type: Fraction

Hourly Values

Mdnt - 1:	0.0380 ratio	8-9 am:	0.6750 ratio	4-5 pm:	0.5986 ratio
1-2 am:	0.0380 ratio	9-10 am:	0.6750 ratio	5-6 pm:	0.3756 ratio
2-3 am:	0.0380 ratio	10-11 am:	0.6750 ratio	6-7 pm:	0.2227 ratio
3-4 am:	0.0380 ratio	11-noon:	0.6750 ratio	7-8 pm:	0.2227 ratio
4-5 am:	0.0380 ratio	noon-1:	0.6750 ratio	8-9 pm:	0.0762 ratio
5-6 am:	0.0380 ratio	1-2 pm:	0.6750 ratio	9-10 pm:	0.0762 ratio
6-7 am:	0.2227 ratio	2-3 pm:	0.6750 ratio	10-11 pm:	0.0380 ratio
7-8 am:	0.5986 ratio	3-4 pm:	0.6750 ratio	11-Mdnt:	0.0380 ratio

Typical Office Ambient Lighting

Schedule Properties — Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: EL1 Bldg OffEq WD — Type: Fraction
Day Schedule Name: EL1 Bldg OffEq WD — Type: Fraction

Hourly Values

Mdnt - 1:	0.0900 ratio	8-9 am:	0.6750 ratio	4-5 pm:	0.6165 ratio
1-2 am:	0.0900 ratio	9-10 am:	0.6750 ratio	5-6 pm:	0.3123 ratio
2-3 am:	0.0900 ratio	10-11 am:	0.6750 ratio	6-7 pm:	0.1660 ratio
3-4 am:	0.0900 ratio	11-noon:	0.5522 ratio	7-8 pm:	0.1660 ratio
4-5 am:	0.0900 ratio	noon-1:	0.5522 ratio	8-9 pm:	0.1192 ratio
5-6 am:	0.0900 ratio	1-2 pm:	0.6750 ratio	9-10 pm:	0.1192 ratio
6-7 am:	0.1660 ratio	2-3 pm:	0.6750 ratio	10-11 pm:	0.0900 ratio
7-8 am:	0.5697 ratio	3-4 pm:	0.6750 ratio	11-Mdnt:	0.0900 ratio

Typical Office Equipment (Office Type)

Schedule Properties — Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: EL1 Bldg TskLt WD — Type: Fraction
Day Schedule Name: EL1 Bldg TskLt WD — Type: Fraction

Hourly Values

Mdnt - 1:	0.0090 ratio	8-9 am:	0.6750 ratio	4-5 pm:	0.5418 ratio
1-2 am:	0.0090 ratio	9-10 am:	0.6750 ratio	5-6 pm:	0.2621 ratio
2-3 am:	0.0090 ratio	10-11 am:	0.6750 ratio	6-7 pm:	0.1089 ratio
3-4 am:	0.0090 ratio	11-noon:	0.4486 ratio	7-8 pm:	0.1089 ratio
4-5 am:	0.0090 ratio	noon-1:	0.4486 ratio	8-9 pm:	0.0756 ratio
5-6 am:	0.0090 ratio	1-2 pm:	0.6750 ratio	9-10 pm:	0.0756 ratio
6-7 am:	0.1089 ratio	2-3 pm:	0.6750 ratio	10-11 pm:	0.0090 ratio
7-8 am:	0.5418 ratio	3-4 pm:	0.6750 ratio	11-Mdnt:	0.0090 ratio

Typical Office Task Lighting

Schedule Properties — Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: EL1 Bldg Misc WD — Type: Fraction
Day Schedule Name: EL1 Bldg Misc WD — Type: Fraction

Hourly Values

Mdnt - 1:	0.1500 ratio	8-9 am:	0.6750 ratio	4-5 pm:	0.6750 ratio
1-2 am:	0.1500 ratio	9-10 am:	0.6750 ratio	5-6 pm:	0.3758 ratio
2-3 am:	0.1500 ratio	10-11 am:	0.6750 ratio	6-7 pm:	0.2235 ratio
3-4 am:	0.1500 ratio	11-noon:	0.6750 ratio	7-8 pm:	0.2235 ratio
4-5 am:	0.1500 ratio	noon-1:	0.6750 ratio	8-9 pm:	0.1500 ratio
5-6 am:	0.1500 ratio	1-2 pm:	0.6750 ratio	9-10 pm:	0.1500 ratio
6-7 am:	0.2235 ratio	2-3 pm:	0.6750 ratio	10-11 pm:	0.1500 ratio
7-8 am:	0.6015 ratio	3-4 pm:	0.6750 ratio	11-Mdnt:	0.1500 ratio

Typical Office Equipment (Miscellaneous)

2003 Commercial Building Energy Consumption Survey (CBECS) Data Table: *Office Consumption*

Released: Dec 2006
Next CBECS will be conducted in 2007

Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003

	All Buildings*			Sum of Major Fuel Consumption			
	Number of Buildings (thousand)	Floorspace (million square feet)	Floorspace per Building (thousand square feet)	Total (trillion Btu)	per Building (million Btu)	per Square Foot (thousand Btu)	per Worker (million Btu)
All Buildings*	4,645	64,783	13.9	5,820	1,253	89.8	79.9
Building Floorspace (Square Feet)							
1,001 to 5,000	2,552	6,789	2.7	672	263	98.9	67.6
5,001 to 10,000	889	6,585	7.4	516	580	78.3	68.7
10,001 to 25,000	738	11,535	15.6	776	1,052	67.3	72.0
25,001 to 50,000	241	8,668	35.9	673	2,790	77.6	75.8
50,001 to 100,000	129	9,057	70.4	759	5,901	83.8	90.0
100,001 to 200,000	65	9,064	138.8	934	14,300	103.0	80.3
200,001 to 500,000	25	7,176	289.0	725	29,189	101.0	105.3
Over 500,000	7	5,908	896.1	766	116,216	129.7	87.6
Principal Building Activity							
Education	386	9,874	25.6	820	2,125	83.1	65.7
Food Sales	226	1,255	5.6	251	1,110	199.7	175.2
Food Service	297	1,654	5.6	427	1,436	258.3	136.5
Health Care	129	3,163	24.6	594	4,612	187.7	94.0
Inpatient	8	1,905	241.4	475	60,152	249.2	127.7
Outpatient	121	1,258	10.4	119	985	94.6	45.8
Lodging	142	5,096	35.8	510	3,578	100.0	207.5
Retail (Other Than Mall)	443	4,317	9.7	319	720	73.9	92.1
Office	824	12,208	14.8	1,134	1,376	92.9	40.3
Public Assembly	277	3,939	14.2	370	1,338	93.9	154.5
Public Order and Safety	71	1,090	15.5	126	1,791	115.8	93.7
Religious Worship	370	3,754	10.1	163	440	43.5	95.6
Service	622	4,050	6.5	312	501	77.0	85.0
Warehouse and Storage	597	10,078	16.9	456	764	45.2	104.3
Other	79	1,738	21.9	286	3,600	164.4	157.1
Vacant	182	2,567	14.1	54	294	20.9	832.1
Year Constructed							
Before 1920	330	3,769	11.4	302	917	80.2	99.3
1920 to 1945	527	6,871	13.0	620	1,176	90.3	101.3
1946 to 1959	562	7,045	12.5	565	1,007	80.3	85.1
1960 to 1969	579	8,101	14.0	737	1,272	90.9	84.6
1970 to 1979	731	10,772	14.7	1,023	1,400	95.0	81.2
1980 to 1989	707	10,332	14.6	1,034	1,463	100.1	68.8
1990 to 1999	876	12,360	14.1	1,098	1,253	88.8	67.8
2000 to 2003	334	5,533	16.6	441	1,319	79.7	98.5
Census Region and Division							
Northeast	726	12,905	17.8	1,271	1,751	98.5	85.3
New England	233	2,964	12.7	294	1,262	99.0	93.0
Middle Atlantic	493	9,941	20.1	978	1,981	98.3	83.2
Midwest	1,266	17,080	13.5	1,690	1,334	98.9	103.2
East North Central	696	11,595	16.7	1,254	1,802	108.1	109.1
West North Central	571	5,485	9.6	436	764	79.5	89.3
South	1,775	23,489	13.2	1,948	1,098	82.9	72.0
South Atlantic	874	12,258	14.0	1,064	1,218	86.8	63.5
East South Central	348	3,393	9.8	309	889	91.1	101.0
West South Central	553	7,837	14.2	575	1,039	73.4	79.2
West	878	11,310	12.9	911	1,037	80.6	63.1
Mountain	299	3,675	12.3	381	1,278	103.8	89.1
Pacific	580	7,635	13.2	530	913	69.4	52.1

Energy Information Administration
2003 Commercial Buildings Energy Consumption Survey: Consumption and Expenditures Tables

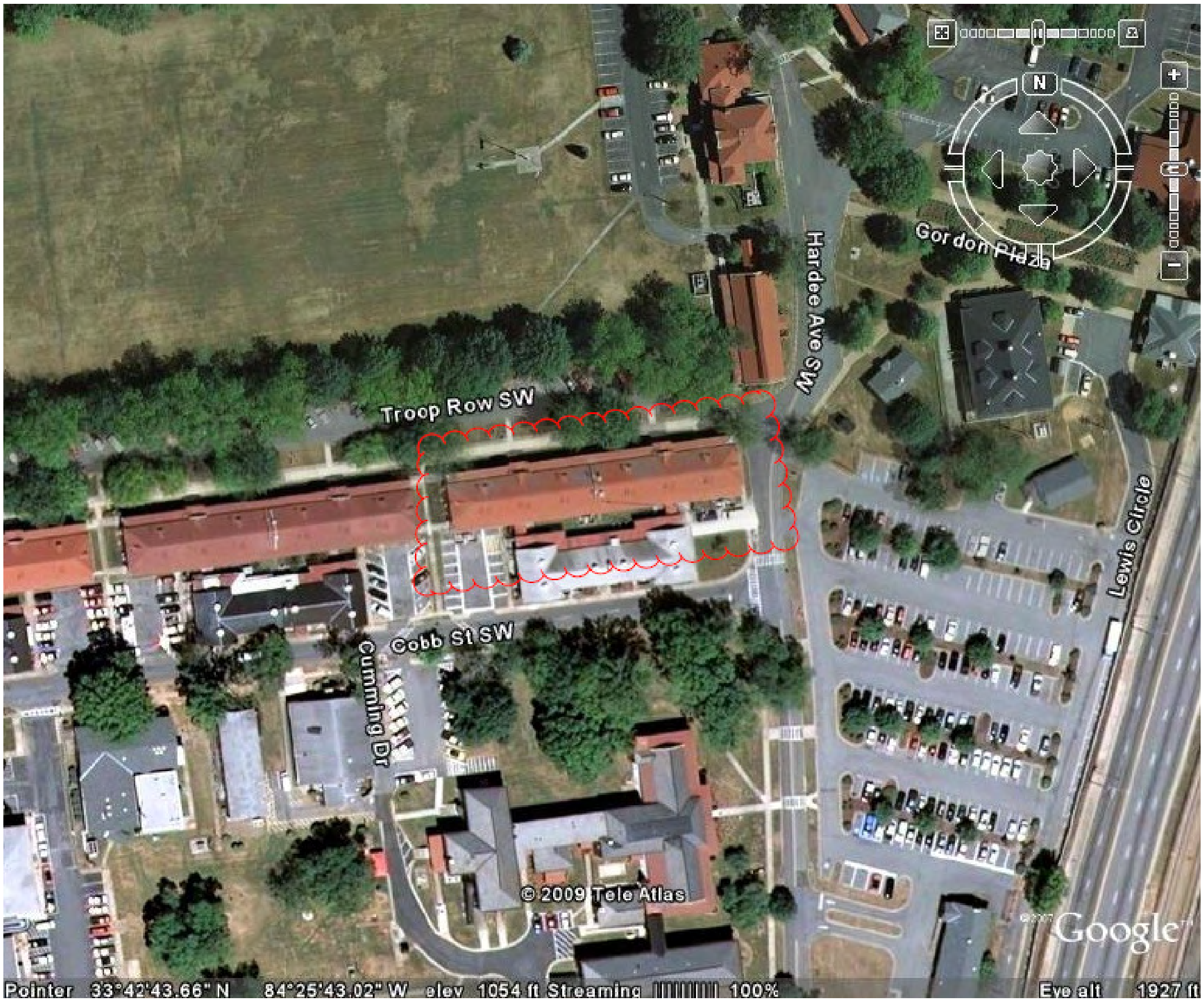
2003 CBECS Data Table: *Residential Consumption*

U.S. Average Site Energy Use and 2030 Challenge Energy Reduction Targets by Space/Building Type (CBECS 2003)[1]

From the Environmental Protection Agency (EPA): Use this chart to find the site fossil-fuel energy targets.

Primary Space/Building Type [2]	Available in Target Finder [3]	Average Source EUI[4] (kBtu/Sq.Ft./Yr)	Average Percent Electric	Average Site EUI [4] (kBtu/Sq.Ft./Yr)	2030 Challenge Site EUI Targets (kBtu/Sq.Ft./Yr) 50% Target	60% Target	70% Target	80% Target	90% Target
Administrative/Professional & Government Office	✓								
Bank	✓								
Clinic/other outpatient health		199.0	76%	84.2	42.1	33.7	25.3	16.8	8.4
Convenience store (with or without gas station)		681.1	90%	241.4	120.7	96.5	72.4	48.3	24.1
Distribution/shipping center		82.9	61%	44.2	22.1	17.7	13.3	8.8	4.4
Fast food		1195.0	64%	534.3	267.2	213.7	160.3	106.9	53.4
Fire station/police station		145.7	56%	77.9	39.0	31.2	23.4	15.6	7.8
Hospital/inpatient health	✓								
Hotel, Motel or inn	✓								
K-12 School	✓								
Medical Office	✓								
Non-refrigerated warehouse	✓								
Nursing home/assisted living		234.8	54%	124.3	62.2	49.7	37.3	24.9	12.4
Post office/postal center		131.9	58%	63.5	31.8	25.4	19.1	12.7	6.4
Preschool/daycare		155.3	60%	75.0	37.5	30.0	22.5	15.0	7.5
Refrigerated warehouse	✓								
Religious worship		77.5	52%	45.9	22.9	18.3	13.8	9.2	4.6
Residence hall/Dormitory	✓								
Restaurant/cafeteria		565.7	53%	301.6	150.8	120.7	90.5	60.3	30.2
Retail store		158.3	67%	72.2	36.1	28.9	21.7	14.4	7.2
Self-storage		10.9	44%	4.0	2.0	1.6	1.2	0.8	0.4
Supermarket/Grocery	✓								
Vehicle repair/service/storage		96.6	64%	50.7	25.3	20.3	15.2	10.1	5.1
Secondary Space/Building Type [2]									
Ambulatory Surgical Center	✓								
Computer Data Center	✓								
Garage	✓								
Open Parking Lot	✓								
Swimming Pool	✓								
Residential Space/Building Type [5]									
Single-Family Detached		-	-	44.7	22.4	17.9	13.4	8.9	4.5
Single-Family Attached		-	-	45.6	22.8	18.2	13.7	9.1	4.6
Multi-Family, 2 to 4 units		-	-	56.1	28.1	22.4	16.8	11.2	5.6
Multi-Family, 5 or more units		-	-	48.5	24.3	19.4	14.6	9.7	4.9
Mobile Homes		-	-	72.0	36.0	28.8	21.6	14.4	7.2

Google Earth Image of Case Study Building



1978 Lighting Power Density (LPD) Calculations

Lighting Power Density (LPD) input for Energy Modeling purposes needs to be expressed in Watts per Square Foot. Below are the calculations used to determine the Light Power Density for and Office building in 1977. This information comes from the "Code for Energy Conservation in New Building Construction" (see Appendix 6).

Baseline LPD Formula & Explanation:

From section **505.3 Lighting Power Budget** of "Code for Energy Conservation in New Building Construction - 1977":

> "General Lighting. In areas surrounding task locations, the average level of general lighting, for budget purposes only, shall be one third the level for the tasks performed in the area but in no case less than **20 footcandles**" (46)."

Conversion calculations for Footcandles to W/sqft follow:

- 1 Foot-Candles (Fc) = 1 Lumen (lm) per Square Foot
  - 20 Fc = 20 lm/sqft
- 16,164 sqft x 20 lm = 323,280 lm   < Total Lumens used in the building
- 323,280 lm / 55 lm/Watt* = 5,878 Watts (5.9 KW)   < Lumens converted to Watts
- 16,164 sqft / 5,878 W = 2.75 W/sqft   < Watts used per Square Foot

(*) 55 lm/Watt per "Code for Energy Conservation in New Building Construction" 1977

ASHRAE Standard 90.1-2004 Section 6 HVAC

ASHRAE Standard 90.1-2004: Table 6.8.1A – Minimum Cooling Efficiencies

TABLE 6.8.1A Electronically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air Conditioners, Air Cooled	<65,000 Btu/h[c]	All	Split System	10.0 SEER (before 1/23/2006) 12.0 SEER (as of 1/23/2006)	ARI 210/240
			Single Package	9.7 SEER (before 1/23/2006) 12.0 SEER (as of 1/23/2006)	

ASHRAE Standard 90.1-2004: Table 6.8.1E – Minimum Heating Efficiencies

TABLE 6.8.1E Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Warm Air Furnace, Gas-Fired	<225,000 Btu/h		78% AFUE or 80% E_t[d]	DOE 10 CFR Part 430 or ANSI Z21.47
	≥225,000 Btu/h	Maximum Capacity[d]	80% E_c[c]	ANSI Z21.47
Warm Air Furnace, Oil-Fired	<225,000 Btu/h		78% AFUE or 80% E_t[d]	DOE 10 CFR Part 430 or UL 727
	≥225,000 Btu/h	Maximum Capacity[e]	81% E_t[f]	UL 727
Warm Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity[e]	80% E_c[g]	ANSI Z83.9
Warm Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity[e]	80% E_c[g]	ANSI Z83.8
Warm Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity[e]	80% E_c[g]	UL 731

a E_t = thermal *efficiency*. See test procedure for detailed discussion.
b Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
c E_c = combustion *efficiency*. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
d Combination units not covered by NAECA (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating.
e Minimum and maximum ratings as provided for and allowed by the unit's controls.
f E_t = thermal *efficiency*. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
g E_c = combustion *efficiency* (100% less flue losses). See test procedure for detailed discussion.

ASHRAE 90.1-2007: Section 9 Table 9.5.1

ANSI/ASHRAE/IESNA Standard 90.1-2007
(Supersedes ANSI/ASHRAE/IESNA Standard 90.1-2004)
Includes ANSI/ASHRAE/IESNA Addenda listed in Appendix F

ASHRAE STANDARD

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IESNA Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada).

ISSN 1041-2336

Jointly sponsored by

Illuminating Engineering Society
Illuminating Engineering Society of North America
www.iesna.org

Approved American National Standard
ANSI
www.ansi.org

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method

Building Area Type[a]	*LPD* (W/ft²)
Automotive facility	0.9
Convention center	1.2
Courthouse	1.2
Dining: bar lounge/leisure	1.3
Dining: cafeteria/fast food	1.4
Dining: family	1.6
Dormitory	1.0
Exercise center	1.0
Gymnasium	1.1
Health-care clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing facility	1.3
Motel	1.0
Motion picture theater	1.2
Multifamily	0.7
Museum	1.1
Office	1.0
Parking garage	0.3
Penitentiary	1.0
Performing arts theater	1.6
Police/fire station	1.0
Post office	1.1
Religious building	1.3
Retail	1.5
School/university	1.2
Sports arena	1.1
Town hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

[a] In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

9.6 Alternative Compliance Path: Space-by-Space Method

9.6.1 Space-by-Space Method of Calculating Interior Lighting Power Allowance. Use the following steps to determine the interior lighting power allowance by the Space-by-Space Method:

a. Determine the appropriate building type from Table 9.6.1. For building types not listed, selection of a reasonably equivalent type shall be permitted.

b. For each space enclosed by partitions 80% or greater than ceiling height, determine the gross interior floor area by measuring to the center of the partition wall. Include the floor area of balconies or other projections. Retail spaces do not have to comply with the 80% partition height requirements.

c. Determine the *interior lighting power allowance* by using the columns designated Space-by-Space Method in Table 9.6.1. Multiply the floor area(s) of the space(s) times the allowed *LPD* for the space type that most closely represents the proposed use of the space(s). The product is the *lighting power allowance* for the space(s). For space types not listed, selection of a reasonable equivalent category shall be permitted.

d. The *interior lighting power allowance* is the sum of *lighting power allowances* of all spaces. Trade-offs among spaces are permitted provided that the total *installed interior lighting power* does not exceed the *interior lighting power allowance*.

9.6.2 Additional Interior Lighting Power. When using the Space-by-Space Method, an increase in the *interior lighting power allowance* is allowed for specific lighting functions. Additional power shall be allowed only if the specified lighting is installed and automatically controlled, separately from the general lighting, to be turned off during nonbusiness hours. This additional power shall be used only for the specified *luminaires* and shall not be used for any other purpose.

An increase in the *interior lighting power allowance* is permitted in the following cases:

a. For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance, such as chandelier-type luminaries or sconces or for highlighting art or exhibits, provided that the additional lighting power shall not exceed 1.0 W/ft² of such spaces.

b. For lighting equipment installed in sales areas and specifically designed and directed to highlight merchandise, calculate the additional lighting power as follows:

Additional Interior Lighting Power Allowance =
1000 watts + (Retail Area 1 × 1.0 W/ft²)
+ (Retail Area 2 × 1.7 W/ft²)
+ (Retail Area 3 × 2.6 W/ft²)
+ (Retail Area 4 × 4.2 W/ft²) ,

where

Retail Area 1 = the floor area for all products not listed in Retail Areas 2, 3, or 4;

Retail Area 2 = the floor area used for the sale of vehicles, sporting goods, and small electronics;

Retail Area 3 = the floor area used for the sale of furniture, clothing, cosmetics, and artwork; and

Retail Area 4 = the floor area used for the sale of jewelry, crystal, and china.

Exception: Other merchandise categories may be included in Retail Areas 2 through 4 above, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is approved by the *authority having jurisdiction*.

9.7 Submittals (Not Used)

9.8 Product Information (Not Used)

CODE FOR ENERGY CONSERVATION (1977): Used for 1978 Baseline Lighting Power Calculations

CODE FOR
ENERGY CONSERVATION
IN
NEW BUILDING CONSTRUCTION

December 1977

3. Swimming Pools.
   a. Heated swimming pools shall be equipped with controls to limit heating water temperatures to no more than 80F.

      EXCEPTION: Pools used for therapeutic purposes are exempt from this requirement when approved by the Building Official.

   b. Uncovered or unenclosed heated pools shall be controlled so that the electric or fossil-fueled pool water heating systems are inoperative whenever the outdoor air temperature is below 60F.

504.3 Pump Operation

Circulating hot water systems shall be arranged so that the circulation pump(s) can be conveniently turned off, automatically or manually, when the hot water system is not in operation.

504.4 Pipe Insulation

For recirculation systems, piping heat loss shall be limited to a maximum of 25 Btu/h ft² of external pipe surface for above ground piping and a maximum of 35 Btu/h ft² of external pipe surface for underground piping. Maximum heat loss shall be determined at a Δt equal to the maximum water temperature minus a design ambient temperature no higher than 65F.

504.5 Conservation of Hot Water

(a) Showers. Showers used for other than safety reasons shall be equipped with flow control devices to limit total flow to a maximum of 3 gpm per shower head.

(b) Lavatories in Restrooms of Public Facilities shall:

1. Be equipped with outlet devices which limit the flow of hot water to a maximum of 0.5 gpm.
2. Be equipped with devices which limit the outlet temperature to a maximum of 110F.
3. Be equipped with self closing valves that limit delivery to a maximum of 0.25 gallons of hot water.

505.0 Electrical Power and Lighting

505.1 General

Electrical distribution and lighting systems shall be designed

44

for efficient distribution and use of electrical energy from the service entrance to and at the points of use as provided herein.

505.2 Electrical Distribution

(a) Power Factor. Utilization equipment, rated greater than 1,000W and lighting equipment greater than 15W, with an inductive reactance load component, shall have a power factor of not less than 85 percent under rated load conditions. Power factor of less than 85 percent shall be corrected to at least 90 percent under rated load conditions. Power factor corrective devices, installed to comply with this Code, shall be switched with the utilization equipment, except where this results in an unsafe condition or interferes with the intended operation of the equipment.

(b) Service Voltage. Where a choice of service voltages is available, a computation shall be made to determine which service voltage would produce the least energy loss, and that voltage shall be selected.

(c) Voltage Drop. In any building, the maximum total voltage drop shall not exceed 3 percent in branch circuits or feeders, for a total of 5 percent to the farthest outlet based on steady state design load conditions.

(d) Lighting Switching. Switching shall be provided for each lighting circuit, or for portions of each circuit, so that the partial lighting required for custodial or for effective complementary use with natural lighting may be operated selectively.

(e) Electrical Energy Determination. In all multi-family dwellings, provision shall be made to determine the energy consumed by each tenant by separately metering individual dwelling units.

   EXCEPTION: Motels, hotels, and dormitories are exempt from these requirements.

505.3 Lighting Power Budget

A lighting power budget is the upper limit of the power to be available to provide the lighting needs in accordance with the criteria and calculation procedure specified herein.

The lighting power budget for the building shall be the sum of the power limits computed for all lighted interior and exterior spaces and shall be determined in accordance with the procedures specified in this section.

45

CODE FOR ENERGY CONSERVATION (1977) CONTINUED

EXCEPTION: One- and two-family detached dwellings and the dwelling portion of multi-family buildings are exempt from the requirements of Section 505.3.

(a) Calculation Methods.

1. The criteria specified below shall be utilized for computation of the lighting power budget. All calculations shall be in accordance with Section 505.3(e), Calculation Procedure.

2. When insufficient information is known about the specific use of the building space (e.g., number of occupants, space function, location of partitions), the budget shall be based on the apparent intended use of the building space.

(b) Building Interiors.

The allowable electric power for lighting shall be established by using the criteria and the calculation procedures specified in Section 505.3(e). The value shall be based on the use for which the space within the building is intended.

1. Illumination Level Criteria. For the purpose of establishing a budget, levels of illumination shall be those listed in Standard RS-8. Those levels shall be used as follows:

a. Task Lighting. In most cases, the levels of illumination listed are for specific tasks. These levels are for the task areas defined in Standard RS-8, or, where not defined, at all usable portions of task surfaces. In some cases, the levels of illumination are listed for locations. These levels are to be considered as average levels.

b. General Lighting. In areas surrounding task locations, the average level of general lighting, for budget purposes only, shall be one-third the level for the tasks performed in the area but in no case less than 20 footcandles. Where more than one task level occurs in a space, the general level shall be one-third the weighted average of the specific task levels.

c. Non-Critical Lighting. In circulation and seating areas where no specific visual tasks occur, the average level of illumination shall be one-third of the average general lighting in the adjacent task spaces but in no case less than 10 footcandles.

46

d. Lighting System Criteria. For the purposes of establishing a power budget, only lamp efficacies and coefficients of utilization (CU), specified in Table 5-10, shall be assumed.

(c) Exceptions to Building Interior Criteria.

1. The criteria of Section 505.3(b) shall not apply to the following areas when calculating the load.

a. Residential type spaces in institutions, such as hospitals, hotels, funeral homes, churches, museums, etc., other than kitchens, bathrooms, laundry areas and public spaces, including lobbies, halls, stairways, basement areas and utility rooms.

b. Theatre auditoriums, entertainment, audio-visual presentations and motion picture and television studios where the lighting is an essential technical element for the function performed.

2. The criteria of 505.3(b)1.*d* shall not apply to the following lamps and luminaires; however, their use shall be accounted for in the calculation of task lighting loads for specific tasks. The allowable load shall be based on the luminaire wattage to achieve the levels of illumination as covered in 505.3(b) using a point calculation method given in Standard RS-8.

a. Luminaires for medical and dental purposes.

b. Luminaires for highlighting applications, such as sculpture exhibits, art exhibits, and individual items of display merchandise.

c. Luminaires for specialized lighting applications (color matching, where electrical interference cannot be tolerated, etc.).

3. The criteria of Table 5-10(C) shall not apply in spaces where it is impractical to control reflectances and where a dirty atmosphere cannot be avoided. Where this condition exists, the values for reflectances and light loss factors shall be those expected to be found and shall be approved by the Building Official. The calculation shall make note of this deviation.

(d) Building Exteriors.

In exterior spaces, the lighting power budget shall be based on the use for which the space is intended.

1. Criteria. The same criteria as those for interior spaces

47

apply for illumination levels and lighting systems with the addition of luminaires for floodlighting. For power budget purposes luminaires shall have a greater percentage of their beam lumens restricted to the area to be lighted and have minimum efficiencies at least as great as those listed in Standard RS-8.

2. Facade Lighting. Facade lighting for budget purposes shall be no greater than 2 percent of the total interior load of the building.

3. Calculation Procedure. In establishing a lighting power budget the following procedures shall be used:

a. Overhead Lighting. The procedure specified in Section 505.3(e) shall be followed for overhead lighting, but using reflectances as found.

b. Floodlighting. The beam lumen method, as shown in Standard RS-8 and a coefficient of beam utilization (CBU) of 0.75 shall be used for floodlighting calculations.

(e) Calculation Procedure.

To establish a lighting power budget, the following procedure shall be used:

1. Determining Illumination Levels and Areas:

a. Determine the visual tasks that are expected to be performed in each space (the commonly found tasks at each work station) and the number of planned work locations where tasks will be performed. If assumptions are made, their bases shall be indicated.

b. Select the illumination level, in footcandles for those expected tasks in accordance with Section 505.3(b)1.*a*.

c. Calculate total task areas to be illuminated to the same level by multiplying the number of work locations by 50 ft² per work location. (Total task area shall not exceed actual total space area.) If actual task area is greater than 50 ft² actual area shall be used. If special task lighting or localized lighting is to be employed, use the actual task areas and point calculation procedures.

d. Calculate the level of general lighting by multiplying the task lighting level by one-third, where there is only one task level, or by taking one-third of the sum of the products of the task levels (*b*) and their areas

48

(c) divided by the total task areas in accordance with Section 505.3(b)1.*b*.

e. Calculate the level of non-critical lighting in accordance with Section 505.3(b)1.c.

f. For area determinations of general and non-critical lighting, calculations shall be based on Standard RS-9, B-3.b, Attachment B.

2. Determining Lighting System Data.

a. Determine light source and luminaire types to use.

b. Determine lamp lumens per watt and luminaire coefficients of utilization for room luminaire mounting height dimensions. Luminaire CUs shall be selected from Std RS-8 or manufacturers' data for types not found in Std RS-8. In all cases, no luminaire shall have a CU for RCR 1 of less than that given in Table 5-10 B. Lamp efficacies shall be those listed in Table 5-10 A.

3. Determining Allowable Wattage.

a. Using data from (e)2. above, the illumination levels and areas determined in (e)1. and the criteria of Table 5-10 C, calculate the allowable wattages using the lumen method.

b. Calculate the total space wattage by adding the task, general and non-critical lighting loads.

c. Add the wattage of luminaires allowed in 505.3(c)2.

49

CODE FOR ENERGY CONSERVATION (1977) CONTINUED

TABLE 5-10 A
LAMP EFFICACIES

Application	Lumens per Watt
Where moderate color rendition is appropriate	55
Where good color rendition is appropriate	40
Where high color rendition is appropriate, spaces are less than 50 ft² or where use of low wattage High Intensity Discharge (HID) lamps under 250 W or flourescent lamps under 40 W is appropriate	25

[1]The initial lumen output per watt input, including ballast losses.

TABLE 5-10 B
LUMINAIRE COEFFICIENTS OF UTILIZATION (CU)[1]

Space Use	Minimum CU (at RCR — 1)
For spaces with tasks subjected to veiling reflections (where design levels of illumination are listed in terms of equivalent sphere illumination (ESI) and where visual comfort is important.	0.55
For spaces without tasks, or with tasks not subjected to veiling reflections, but where visual comfort is important.	0.63
For spaces without tasks and where visual comfort is not a criterion.	0.70

[1] Coefficients of utilization (CU's) are to be for luminaires for use in the types of spaces listed, and those luminaires shall have a CU of no less than that listed for each type space for a Room Cavity Ratio (RCR) of 1 and reflect areas as in Table 5-10C.

TABLE 5-10 C
REFLECTANCES & LIGHT LOSS FACTORS

INTERIOR SPACES[1]	REFLECTANCE	LIGHT LOSS FACTOR
Ceiling Cavity	80 percent	
Wall	50 percent	0.70
Floor Cavity	20 percent	

[1]For interior spaces, initial cavity and surface reflectances shall be shown.

50

SECTION 6
BUILDING DESIGN BY ACCEPTABLE PRACTICE

601.0 Scope

601.1 General

The requirements contained in this section are applicable only to buildings less than five thousand square feet in gross floor area and three stories or less in height. The provisions of this section are limited to residential buildings that are heated or mechanically cooled and to other buildings that are heated only. Buildings constructed in accordance with this section are deemed to comply with this Code.

602.0 Building Envelope Requirements

602.1 General

The various wall, roof and floor assemblies in Appendix Tables 6-1A, B and C, 6-2 and 6-3 are typical and are not intended to be all inclusive. Other assemblies may be used provided documentation is submitted indicating the thermal transmittance value of the opaque section. Such documentation shall be in accordance with accepted engineering practice.

The proposed design may take into consideration the thermal mass of the building when considering energy conservation, when approved by Building Official.

602.2 Criteria—Heating and Cooling

(a) Walls. The combined thermal transmittance value (U_o) of the exterior walls shall not exceed the value specified in Table 5-1 or 5-2 as appropriate for the building type. The U_o of the wall shall be determined by selecting the U_w

51

TABLE 6-8
MINIMUM PIPE INSULATION

PIPING SYSTEM TYPES	FLUID TEMPERATURE RANGE, F	INSULATION THICKNESS IN INCHES FOR PIPE SIZES: RUN-OUTS UP TO 2"[1]	1" AND LESS	1¼ to 2"	2½ to 4"	5" to 6"	8" AND LARGER
HEATING SYSTEMS							
Steam and Hot Water							
High Pressure/Temp	306-450	1½	1½	2	2½	3½	3½
Med. Pressure/Temp	251-305	1½	1½	2	2½	3	3
Low Pressure/Temp	201-250	1	1	1½	1½	2	2
Low Temperature	120-200	½	¾	1	1	1	1½
Steam Condensate (for Feed Water)	Any	1	1	1	1½	1½	2
COOLING SYSTEMS							
Chilled Water	40-55	½	½	¾	1	1	1
Refrigerant, or Brine	Below 40	1	1	1½	1½	1½	1½

[1]Runouts not exceeding 12' in length to individual Terminal Units.

604.0 Service Water Heating

604.1 Service Water Heating

Water heating storage tanks, boilers and piping for all water heating systems shall be installed in accordance with Section 504.2.

(a) Performance Efficiency. Water heaters shall be labeled as meeting the efficiency requirements of Section 504.2(a).

(b) Temperature Controls.

1. Service water heating systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use.
2. Shut-down. A separate switch shall be provided to permit turning off the energy supplied to electric service water heating systems. A separate value shall be provided to permit turning off the energy supplied to the main burner(s) of all other types of service water heating systems.
3. Swimming Pools.
   a. Heated swimming pools shall be equipped with controls to limit heating water temperatures to no more than 80F.

      EXCEPTIONS: Pools used for therapeutic purposes are exempt from this requirement when approved by the Building Official.

   b. Uncovered or unenclosed heated pools shall be controlled so that the electric or fossil-fueled pool water heating systems are inoperative whenever the outdoor air temperature is below 60F.

56

604.2 Pump Operation

Circulating hot water systems shall be arranged so that the circulating pump(s) can be conveniently turned off, automatically or manually, when the hot water system is not in operation.

604.3 Pipe Insulation

For recirculating systems piping heat loss shall be limited to a maximum of 25 Btu/h ft² of external pipe surface for above ground piping and a maximum of 35 Btu/h ft² of external pipe surface for underground piping. Maximum heat loss shall be determined at a Δt equal to the maximum water temperature minus a design ambient temperature of no higher than 65F.

604.4 Conservation of Hot Water

(a) Showers used for other than safety reasons shall be equipped with flow control devices to limit total flow to a maximum of 3 gpm per shower head.

(b) Lavatories in restrooms of public facilities shall conform to the requirements of Section 504.5(b).

605.0 Electrical Power and Lighting

The electrical power distribution and lighting systems shall conform to the requirements of Sections 505.2 and 505.3.

EXCEPTION: One- and two-family detached dwellings and the dwelling portion of multi-family buildings are exempt from the requirements of this section.

57

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 | Run Date/Time: 12/05/09 @ 16:53

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	15,174	0	9,649	259,975	0	10,473	381,910
1 0+DG Window	58,412	3,644	24,585	0	14,046	0	9,019	241,124	0	10,473	361,303
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	15,246	0	9,649	260,601	0	10,473	382,609
3 0+LPD	33,514	3,644	24,585	0	14,680	0	9,476	253,918	0	10,473	350,291
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	15,205	0	9,087	251,044	0	10,473	372,452
5 0+Combo of ECMs	33,514	3,644	24,585	0	13,294	0	8,104	222,985	0	10,473	316,599

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.13 (7%)	--	0.63 (7%)	18.85 (7%)	--	0.00 (0%)	20.61 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.07 (-0%)	--	0.00 (0%)	-0.63 (-0%)	--	0.00 (0%)	-0.70 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.49 (3%)	--	0.17 (2%)	6.06 (2%)	--	0.00 (0%)	31.62 (8%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.03 (-0%)	--	0.56 (6%)	8.93 (3%)	--	0.00 (0%)	9.46 (2%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.88 (12%)	--	1.55 (16%)	36.99 (14%)	--	0.00 (0%)	65.31 (17%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.13 (7%)	--	0.63 (7%)	18.85 (7%)	--	0.00 (0%)	20.61 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.07 (-0%)	--	0.00 (0%)	-0.63 (-0%)	--	0.00 (0%)	-0.70 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.49 (3%)	--	0.17 (2%)	6.06 (2%)	--	0.00 (0%)	31.62 (8%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.03 (-0%)	--	0.56 (6%)	8.93 (3%)	--	0.00 (0%)	9.46 (2%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.88 (12%)	--	1.55 (16%)	36.99 (14%)	--	0.00 (0%)	65.31 (17%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 Run Date/Time: 12/05/09 @ 16:53

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	3.3	0.0	1.1	32.1	0.0	0.0	63.6
1 0+DG Window	19.0	1.4	6.7	0.0	3.0	0.0	1.0	29.4	0.0	0.0	60.6
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.3	0.0	1.1	32.1	0.0	0.0	63.6
3 0+LPD	10.9	1.4	6.7	0.0	3.2	0.0	1.1	31.4	0.0	0.0	54.7
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.5	0.0	1.0	30.2	0.0	0.0	61.9
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.9	0.0	0.9	26.6	0.0	0.0	49.4

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.30 (9%)	--	0.07 (7%)	2.70 (8%)	--	--	3.07 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.16 (5%)	--	0.02 (2%)	0.65 (2%)	--	--	8.93 (14%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.16 (-5%)	--	0.06 (6%)	1.83 (6%)	--	--	1.74 (3%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.41 (12%)	--	0.18 (16%)	5.51 (17%)	--	--	14.20 (22%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.30 (9%)	--	0.07 (7%)	2.70 (8%)	--	--	3.07 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.16 (5%)	--	0.02 (2%)	0.65 (2%)	--	--	8.93 (14%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.16 (-5%)	--	0.06 (6%)	1.83 (6%)	--	--	1.74 (3%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.41 (12%)	--	0.18 (16%)	5.51 (17%)	--	--	14.20 (22%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 Run Date/Time: 12/05/09 @ 16:53

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	3.3	0.0	1.1	32.1	0.0	2.9	63.6
1 0+DG Window	19.0	1.4	6.7	0.0	3.0	0.0	1.0	29.4	0.0	2.9	60.6
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.3	0.0	1.1	32.1	0.0	2.9	63.6
3 0+LPD	10.9	1.4	6.7	0.0	3.2	0.0	1.1	31.4	0.0	2.9	54.7
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.5	0.0	1.0	30.2	0.0	2.9	61.9
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.9	0.0	0.9	26.6	0.0	2.9	49.4
Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**											
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.30 (9%)	--	0.07 (7%)	2.71 (8%)	--	0.00 (0%)	3.07 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	--	0.00 (0%)	-0.01 (-0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (4%)	--	0.02 (2%)	0.64 (2%)	--	0.00 (0%)	8.93 (14%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.17 (-5%)	--	0.06 (6%)	1.84 (6%)	--	0.00 (0%)	1.74 (3%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.39 (12%)	--	0.18 (16%)	5.53 (17%)	--	0.00 (0%)	14.20 (22%)
Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**											
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.30 (9%)	--	0.07 (7%)	2.71 (8%)	--	0.00 (0%)	3.07 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	--	0.00 (0%)	-0.01 (-0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (4%)	--	0.02 (2%)	0.64 (2%)	--	0.00 (0%)	8.93 (14%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.17 (-5%)	--	0.06 (6%)	1.84 (6%)	--	0.00 (0%)	1.74 (3%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.39 (12%)	--	0.18 (16%)	5.53 (17%)	--	0.00 (0%)	14.20 (22%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 | Run Date/Time: 12/05/09 @ 16:53

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.2	0.0	29.2
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.2	0.0	29.2
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.1	0.0	29.1
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.2	0.0	29.2
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.1	0.0	29.1
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0	0.0	29.0

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.09 (0%)	--	0.09 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.11 (0%)	--	0.11 (0%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.24 (1%)	--	0.24 (1%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.09 (0%)	--	0.09 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.11 (0%)	--	0.11 (0%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.24 (1%)	--	0.24 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 Run Date/Time: 12/05/09 @ 16:21

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	19,389	0	10,337	285,343	0	10,473	412,182
1 0+DG Window	58,412	3,644	24,585	0	17,713	0	9,483	261,692	0	10,473	386,002
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	19,448	0	10,337	285,992	0	10,473	412,891
3 0+LPD	33,514	3,644	24,585	0	18,659	0	10,132	277,736	0	10,473	378,744
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	18,744	0	9,481	266,364	0	10,473	391,704
5 0+Combo of ECMs	33,514	3,644	24,585	0	15,877	0	8,317	231,046	0	10,473	327,455

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.68 (9%)	--	0.85 (8%)	23.65 (8%)	--	0.00 (0%)	26.18 (6%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.06 (-0%)	--	0.00 (0%)	-0.65 (-0%)	--	0.00 (0%)	-0.71 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.73 (4%)	--	0.20 (2%)	7.61 (3%)	--	0.00 (0%)	33.44 (8%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.64 (3%)	--	0.86 (8%)	18.98 (7%)	--	0.00 (0%)	20.48 (5%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.51 (18%)	--	2.02 (20%)	54.30 (19%)	--	0.00 (0%)	84.73 (21%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.68 (9%)	--	0.85 (8%)	23.65 (8%)	--	0.00 (0%)	26.18 (6%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.06 (-0%)	--	0.00 (0%)	-0.65 (-0%)	--	0.00 (0%)	-0.71 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.73 (4%)	--	0.20 (2%)	7.61 (3%)	--	0.00 (0%)	33.44 (8%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.64 (3%)	--	0.86 (8%)	18.98 (7%)	--	0.00 (0%)	20.48 (5%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.51 (18%)	--	2.02 (20%)	54.30 (19%)	--	0.00 (0%)	84.73 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 Run Date/Time: 12/05/09 @ 16:21

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

Annual Energy Coincident Demand (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	3.9	0.0	1.2	34.5	0.0	0.0	66.8
1 0+DG Window	19.0	1.4	6.7	0.0	3.5	0.0	1.1	31.3	0.0	0.0	63.1
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.9	0.0	1.2	34.5	0.0	0.0	66.8
3 0+LPD	10.9	1.4	6.7	0.0	3.8	0.0	1.2	33.8	0.0	0.0	57.7
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	4.0	0.0	1.1	31.6	0.0	0.0	63.8
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	3.3	0.0	0.9	27.3	0.0	0.0	50.5

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.41 (10%)	--	0.10 (8%)	3.19 (9%)	--	--	3.70 (6%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.19 (5%)	--	0.02 (2%)	0.76 (2%)	--	--	9.09 (14%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.05 (-1%)	--	0.10 (8%)	2.93 (8%)	--	--	2.97 (4%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.69 (17%)	--	0.23 (20%)	7.28 (21%)	--	--	16.31 (24%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.41 (10%)	--	0.10 (8%)	3.19 (9%)	--	--	3.70 (6%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.19 (5%)	--	0.02 (2%)	0.76 (2%)	--	--	9.09 (14%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.05 (-1%)	--	0.10 (8%)	2.93 (8%)	--	--	2.97 (4%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.69 (17%)	--	0.23 (20%)	7.28 (21%)	--	--	16.31 (24%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 | Run Date/Time: 12/05/09 @ 16:21

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	3.9	0.0	1.2	34.6	0.0	2.9	66.8
1 0+DG Window	19.0	1.4	6.7	0.0	3.5	0.0	1.1	31.4	0.0	2.9	63.1
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.9	0.0	1.2	34.6	0.0	2.9	66.8
3 0+LPD	10.9	1.4	6.7	0.0	3.8	0.0	1.2	33.8	0.0	2.9	57.7
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	4.0	0.0	1.1	31.6	0.0	2.9	63.8
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	3.3	0.0	0.9	27.3	0.0	2.9	50.5

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.41 (10%)	--	0.10 (8%)	3.20 (9%)	--	0.00 (0%)	3.70 (6%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.19 (5%)	--	0.02 (2%)	0.77 (2%)	--	0.00 (0%)	9.09 (14%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.05 (-1%)	--	0.10 (8%)	2.93 (8%)	--	0.00 (0%)	2.97 (4%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.69 (17%)	--	0.23 (20%)	7.30 (21%)	--	0.00 (0%)	16.31 (24%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.41 (10%)	--	0.10 (8%)	3.20 (9%)	--	0.00 (0%)	3.70 (6%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.19 (5%)	--	0.02 (2%)	0.77 (2%)	--	0.00 (0%)	9.09 (14%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.05 (-1%)	--	0.10 (8%)	2.93 (8%)	--	0.00 (0%)	2.97 (4%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.69 (17%)	--	0.23 (20%)	7.30 (21%)	--	0.00 (0%)	16.31 (24%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 Run Date/Time: 12/05/09 @ 16:21

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.7	0.0	27.7
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.7	0.0	27.7
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.7	0.0	27.7
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.7	0.0	27.7
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.6	0.0	27.6
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.6	0.0	27.6

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.04 (0%)	--	0.04 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.10 (0%)	--	0.10 (0%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.16 (1%)	--	0.16 (1%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.04 (0%)	--	0.04 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.10 (0%)	--	0.10 (0%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.16 (1%)	--	0.16 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 Run Date/Time: 12/05/09 @ 15:25

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0	Base Design	58,412	3,644	24,585	0	13,484	0	7,937	227,249	0	10,473	345,784
1	0+DG Window	58,412	3,644	24,585	0	12,471	0	7,359	210,431	0	10,473	327,375
2	0+R-38 Roof Insulation	58,412	3,644	24,585	0	13,488	0	7,937	227,298	0	10,473	345,838
3	0+LPD	33,514	3,644	24,585	0	12,974	0	7,758	221,311	0	10,473	314,258
4	0+R-19 Wall Insulation	58,412	3,644	24,585	0	14,150	0	7,797	227,037	0	10,473	346,099
5	0+Combo of ECMs	33,514	3,644	24,585	0	12,274	0	6,956	201,088	0	10,473	292,535

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.01 (8%)	--	0.58 (7%)	16.82 (7%)	--	0.00 (0%)	18.41 (5%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.00 (-0%)	--	0.00 (0%)	-0.05 (-0%)	--	0.00 (0%)	-0.05 (-0%)
3	0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.51 (4%)	--	0.18 (2%)	5.94 (3%)	--	0.00 (0%)	31.53 (9%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.67 (-5%)	--	0.14 (2%)	0.21 (0%)	--	0.00 (0%)	-0.31 (-0%)
5	0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.21 (9%)	--	0.98 (12%)	26.16 (12%)	--	0.00 (0%)	53.25 (15%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.01 (8%)	--	0.58 (7%)	16.82 (7%)	--	0.00 (0%)	18.41 (5%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.00 (-0%)	--	0.00 (0%)	-0.05 (-0%)	--	0.00 (0%)	-0.05 (-0%)
3	0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.51 (4%)	--	0.18 (2%)	5.94 (3%)	--	0.00 (0%)	31.53 (9%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.67 (-5%)	--	0.14 (2%)	0.21 (0%)	--	0.00 (0%)	-0.31 (-0%)
5	0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.21 (9%)	--	0.98 (12%)	26.16 (12%)	--	0.00 (0%)	53.25 (15%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 Run Date/Time: 12/05/09 @ 15:25

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	3.0	0.0	0.9	27.0	0.0	0.0	58.0
1 0+DG Window	19.0	1.4	6.7	0.0	2.7	0.0	0.8	24.8	0.0	0.0	55.6
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.0	0.0	0.9	27.0	0.0	0.0	58.0
3 0+LPD	10.9	1.4	6.7	0.0	2.8	0.0	0.9	26.4	0.0	0.0	49.1
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.2	0.0	0.9	26.6	0.0	0.0	57.9
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.7	0.0	0.8	23.5	0.0	0.0	46.0

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.16 (8%)	--	--	2.48 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	--	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (5%)	--	0.02 (2%)	0.63 (2%)	--	--	8.90 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.24 (-8%)	--	0.02 (2%)	0.37 (1%)	--	--	0.14 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.27 (9%)	--	0.11 (12%)	3.51 (13%)	--	--	12.00 (21%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.16 (8%)	--	--	2.48 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	--	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (5%)	--	0.02 (2%)	0.63 (2%)	--	--	8.90 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.24 (-8%)	--	0.02 (2%)	0.37 (1%)	--	--	0.14 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.27 (9%)	--	0.11 (12%)	3.51 (13%)	--	--	12.00 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 Run Date/Time: 12/05/09 @ 15:25

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	3.0	0.0	0.9	27.0	0.0	2.9	58.0
1 0+DG Window	19.0	1.4	6.7	0.0	2.7	0.0	0.8	24.8	0.0	2.9	55.6
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.0	0.0	0.9	27.0	0.0	2.9	58.0
3 0+LPD	10.9	1.4	6.7	0.0	2.8	0.0	0.9	26.4	0.0	2.9	49.1
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.2	0.0	0.9	26.6	0.0	2.9	57.9
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.7	0.0	0.8	23.5	0.0	2.9	46.0

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.16 (8%)	--	0.00 (0%)	2.48 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (5%)	--	0.02 (2%)	0.63 (2%)	--	0.00 (0%)	8.90 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.24 (-8%)	--	0.02 (2%)	0.37 (1%)	--	0.00 (0%)	0.14 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.27 (9%)	--	0.11 (12%)	3.51 (13%)	--	0.00 (0%)	12.00 (21%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.16 (8%)	--	0.00 (0%)	2.48 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (5%)	--	0.02 (2%)	0.63 (2%)	--	0.00 (0%)	8.90 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.24 (-8%)	--	0.02 (2%)	0.37 (1%)	--	0.00 (0%)	0.14 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.27 (9%)	--	0.11 (12%)	3.51 (13%)	--	0.00 (0%)	12.00 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 Run Date/Time: 12/05/09 @ 15:25

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.2	0.0	26.2
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.1	0.0	26.1
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.1	0.0	26.1
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.2	0.0	26.2
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0	0.0	26.0
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.9	0.0	25.9
Incremental SAVINGS (MBtu) (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)										
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.04 (0%)	--	0.04 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.15 (1%)	--	0.15 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.22 (1%)	--	0.22 (1%)
Cumulative SAVINGS (MBtu) (values (and % savings) are relative to the Base Case, negative entries indicate increased use)										
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.04 (0%)	--	0.04 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.15 (1%)	--	0.15 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.22 (1%)	--	0.22 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 Run Date/Time: 12/05/09 @ 14:32

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	16,383	0	8,082	236,331	0	10,473	357,910
1 0+DG Window	58,412	3,644	24,585	0	15,137	0	7,492	218,767	0	10,473	338,510
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	16,383	0	8,082	236,354	0	10,473	357,933
3 0+LPD	33,514	3,644	24,585	0	15,678	0	7,875	229,089	0	10,473	324,858
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	16,512	0	7,787	228,637	0	10,473	350,051
5 0+Combo of ECMs	33,514	3,644	24,585	0	14,195	0	6,918	201,152	0	10,473	294,480

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.25 (8%)	--	0.59 (7%)	17.56 (7%)	--	0.00 (0%)	19.40 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.00 (-0%)	--	0.00 (0%)	-0.02 (-0%)	--	0.00 (0%)	-0.02 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.70 (4%)	--	0.21 (3%)	7.24 (3%)	--	0.00 (0%)	33.05 (9%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.13 (-1%)	--	0.29 (4%)	7.69 (3%)	--	0.00 (0%)	7.86 (2%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	2.19 (13%)	--	1.16 (14%)	35.18 (15%)	--	0.00 (0%)	63.43 (18%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.25 (8%)	--	0.59 (7%)	17.56 (7%)	--	0.00 (0%)	19.40 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.00 (-0%)	--	0.00 (0%)	-0.02 (-0%)	--	0.00 (0%)	-0.02 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.70 (4%)	--	0.21 (3%)	7.24 (3%)	--	0.00 (0%)	33.05 (9%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.13 (-1%)	--	0.29 (4%)	7.69 (3%)	--	0.00 (0%)	7.86 (2%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	2.19 (13%)	--	1.16 (14%)	35.18 (15%)	--	0.00 (0%)	63.43 (18%)

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

Annual Energy Coincident Demand (kW)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0	Base Design	19.0	1.4	6.7	0.0	3.0	0.0	0.9	27.7	0.0	0.0	58.7
1	0+DG Window	19.0	1.4	6.7	0.0	2.7	0.0	0.9	25.5	0.0	0.0	56.2
2	0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.0	0.0	0.9	27.7	0.0	0.0	58.7
3	0+LPD	10.9	1.4	6.7	0.0	2.8	0.0	0.9	26.9	0.0	0.0	49.7
4	0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.2	0.0	0.9	26.6	0.0	0.0	57.8
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	2.6	0.0	0.8	23.3	0.0	0.0	45.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.21 (8%)	--	--	2.53 (4%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	--	0.02 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.16 (5%)	--	0.02 (3%)	0.78 (3%)	--	--	9.06 (15%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.18 (-6%)	--	0.03 (4%)	1.08 (4%)	--	--	0.93 (2%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.35 (12%)	--	0.13 (14%)	4.34 (16%)	--	--	12.93 (22%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.21 (8%)	--	--	2.53 (4%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	--	0.02 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.16 (5%)	--	0.02 (3%)	0.78 (3%)	--	--	9.06 (15%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.18 (-6%)	--	0.03 (4%)	1.08 (4%)	--	--	0.93 (2%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.35 (12%)	--	0.13 (14%)	4.34 (16%)	--	--	12.93 (22%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 Run Date/Time: 12/05/09 @ 14:32

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	3.0	0.0	0.9	27.7	0.0	2.9	58.7
1 0+DG Window	19.0	1.4	6.7	0.0	2.8	0.0	0.9	25.5	0.0	2.9	56.2
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.0	0.0	0.9	27.7	0.0	2.9	58.7
3 0+LPD	10.9	1.4	6.7	0.0	2.9	0.0	0.9	26.9	0.0	2.9	49.7
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.2	0.0	0.9	26.6	0.0	2.9	57.8
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.7	0.0	0.8	23.3	0.0	2.9	45.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

Incremental SAVINGS (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.26 (9%)	--	0.07 (7%)	2.22 (8%)	--	0.00 (0%)	2.53 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.01 (0%)	--	0.00 (0%)	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.12 (4%)	--	0.02 (3%)	0.78 (3%)	--	0.00 (0%)	9.06 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.15 (-5%)	--	0.03 (4%)	1.09 (4%)	--	0.00 (0%)	0.93 (2%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.38 (12%)	--	0.13 (14%)	4.35 (16%)	--	0.00 (0%)	12.93 (22%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

Cumulative SAVINGS (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.26 (9%)	--	0.07 (7%)	2.22 (8%)	--	0.00 (0%)	2.53 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.01 (0%)	--	0.00 (0%)	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.12 (4%)	--	0.02 (3%)	0.78 (3%)	--	0.00 (0%)	9.06 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.15 (-5%)	--	0.03 (4%)	1.09 (4%)	--	0.00 (0%)	0.93 (2%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.38 (12%)	--	0.13 (14%)	4.35 (16%)	--	0.00 (0%)	12.93 (22%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 Run Date/Time: 12/05/09 @ 14:32

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.9	0.0	24.9
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.9	0.0	24.9
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.9	0.0	24.9
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.9	0.0	24.9
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.8	0.0	24.8
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.7	0.0	24.7

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.02 (0%)	--	0.02 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.12 (0%)	--	0.12 (0%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.16 (1%)	--	0.16 (1%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.02 (0%)	--	0.02 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.12 (0%)	--	0.12 (0%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.16 (1%)	--	0.16 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 Run Date/Time: 12/05/09 @ 16:03

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	15,253	0	6,614	201,124	0	10,473	320,105
1 0+DG Window	58,412	3,644	24,585	0	14,185	0	6,177	187,014	0	10,473	304,489
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	15,250	0	6,614	201,157	0	10,473	320,134
3 0+LPD	33,514	3,644	24,585	0	14,493	0	6,397	193,992	0	10,473	287,098
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	15,617	0	6,496	197,460	0	10,473	316,687
5 0+Combo of ECMs	33,514	3,644	24,585	0	13,519	0	5,904	174,864	0	10,473	266,504

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.07 (7%)	--	0.44 (7%)	14.11 (7%)	--	0.00 (0%)	15.62 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	--	0.00 (0%)	-0.03 (-0%)	--	0.00 (0%)	-0.03 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.76 (5%)	--	0.22 (3%)	7.13 (4%)	--	0.00 (0%)	33.01 (10%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.36 (-2%)	--	0.12 (2%)	3.66 (2%)	--	0.00 (0%)	3.42 (1%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.73 (11%)	--	0.71 (11%)	26.26 (13%)	--	0.00 (0%)	53.60 (17%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.07 (7%)	--	0.44 (7%)	14.11 (7%)	--	0.00 (0%)	15.62 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	--	0.00 (0%)	-0.03 (-0%)	--	0.00 (0%)	-0.03 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.76 (5%)	--	0.22 (3%)	7.13 (4%)	--	0.00 (0%)	33.01 (10%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.36 (-2%)	--	0.12 (2%)	3.66 (2%)	--	0.00 (0%)	3.42 (1%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.73 (11%)	--	0.71 (11%)	26.26 (13%)	--	0.00 (0%)	53.60 (17%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 Run Date/Time: 12/05/09 @ 16:03

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	2.6	0.0	0.8	23.0	0.0	0.0	53.5
1 0+DG Window	19.0	1.4	6.7	0.0	2.4	0.0	0.7	21.4	0.0	0.0	51.6
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	2.6	0.0	0.8	23.0	0.0	0.0	53.5
3 0+LPD	10.9	1.4	6.7	0.0	2.4	0.0	0.7	22.2	0.0	0.0	44.4
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	2.7	0.0	0.7	22.6	0.0	0.0	53.2
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.3	0.0	0.7	20.0	0.0	0.0	42.0

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.19 (7%)	--	0.05 (7%)	1.63 (7%)	--	--	1.87 (3%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (6%)	--	0.02 (3%)	0.81 (4%)	--	--	9.09 (17%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.16 (-6%)	--	0.01 (2%)	0.41 (2%)	--	--	0.26 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.25 (10%)	--	0.08 (11%)	3.02 (13%)	--	--	11.46 (21%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.19 (7%)	--	0.05 (7%)	1.63 (7%)	--	--	1.87 (3%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (6%)	--	0.02 (3%)	0.81 (4%)	--	--	9.09 (17%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.16 (-6%)	--	0.01 (2%)	0.41 (2%)	--	--	0.26 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.25 (10%)	--	0.08 (11%)	3.02 (13%)	--	--	11.46 (21%)

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	2.6	0.0	0.8	23.0	0.0	2.9	53.5
1 0+DG Window	19.0	1.4	6.7	0.0	2.4	0.0	0.7	21.4	0.0	2.9	51.6
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	2.6	0.0	0.8	23.0	0.0	2.9	53.5
3 0+LPD	10.9	1.4	6.7	0.0	2.5	0.0	0.7	22.2	0.0	2.9	44.4
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	2.8	0.0	0.7	22.6	0.0	2.9	53.2
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.4	0.0	0.7	20.0	0.0	2.9	42.0

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.19 (7%)	--	0.05 (7%)	1.63 (7%)	--	0.00 (0%)	1.87 (3%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (6%)	--	0.02 (3%)	0.81 (4%)	--	0.00 (0%)	9.09 (17%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.17 (-6%)	--	0.01 (2%)	0.41 (2%)	--	0.00 (0%)	0.26 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.26 (10%)	--	0.08 (11%)	3.02 (13%)	--	0.00 (0%)	11.46 (21%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.19 (7%)	--	0.05 (7%)	1.63 (7%)	--	0.00 (0%)	1.87 (3%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (6%)	--	0.02 (3%)	0.81 (4%)	--	0.00 (0%)	9.09 (17%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.17 (-6%)	--	0.01 (2%)	0.41 (2%)	--	0.00 (0%)	0.26 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.26 (10%)	--	0.08 (11%)	3.02 (13%)	--	0.00 (0%)	11.46 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 Run Date/Time: 12/05/09 @ 16:03

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.0	0.0	22.0
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.0	0.0	22.0
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.0	0.0	22.0
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.0	0.0	22.0
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8	0.0	21.8
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8	0.0	21.8

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
3 0+LPD	--	--	--	--	--	--	--	-0.00 (-0%)	--	-0.00 (-0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.13 (1%)	--	0.13 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.16 (1%)	--	0.16 (1%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
3 0+LPD	--	--	--	--	--	--	--	-0.00 (-0%)	--	-0.00 (-0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.13 (1%)	--	0.13 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.16 (1%)	--	0.16 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 HVAC Run Date/Time: 12/29/09 @ 13:52

Annual Electric Energy by Enduse (pg 1 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (kWh)											
0 Base Design	58,412	3,644	24,585	0	8,335	0	2,923	81,866	0	10,473	190,238
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	8,107	0	2,921	71,831	0	10,473	155,075

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.23 (3%)	--	0.00 (0%)	10.04 (12%)	--	0.00 (0%)	35.16 (18%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.23 (3%)	--	0.00 (0%)	10.04 (12%)	--	0.00 (0%)	35.16 (18%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 HVAC | Run Date/Time: 12/29/09 @ 13:52

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

Annual Energy Coincident Demand (kW)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	24.7	0.0	0.0	12.9	0.0	0.0	64.8
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	22.7	0.0	0.0	12.0	0.0	0.0	53.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	1.95 (8%)	--	--	0.91 (7%)	--	--	10.97 (17%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	1.95 (8%)	--	--	0.91 (7%)	--	--	10.97 (17%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 HVAC Run Date/Time: 12/29/09 @ 13:52

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	25.1	0.0	0.6	12.9	0.0	2.9	64.8
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	22.7	0.0	0.6	12.0	0.0	2.9	53.8
Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**											
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	2.34 (9%)	--	0.00 (0%)	0.91 (7%)	--	0.00 (0%)	10.97 (17%)
Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**											
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	2.34 (9%)	--	0.00 (0%)	0.91 (7%)	--	0.00 (0%)	10.97 (17%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 HVAC Run Date/Time: 12/29/09 @ 13:52

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	1,529.4	0.0	0.0	55.8	0.0	0.0	31.3	0.0	1,616.4
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	1,128.6	0.0	0.0	60.5	0.0	0.0	31.1	0.0	1,220.2

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	400.71 (26%)	--	--	-4.71 (-8%)	--	--	0.22 (1%)	--	396.22 (25%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	400.71 (26%)	--	--	-4.71 (-8%)	--	--	0.22 (1%)	--	396.22 (25%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 HVAC | Run Date/Time: 12/29/09 @ 14:06

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	23,119	0	2,300	84,144	0	10,473	206,677
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	19,150	0	2,299	68,991	0	10,473	162,656

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.97 (17%)	--	0.00 (0%)	15.15 (18%)	--	0.00 (0%)	44.02 (21%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.97 (17%)	--	0.00 (0%)	15.15 (18%)	--	0.00 (0%)	44.02 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 HVAC | Run Date/Time: 12/29/09 @ 14:06

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	37.7	0.0	0.0	13.9	0.0	0.0	78.7
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	32.5	0.0	0.0	12.0	0.0	0.0	63.6

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.15 (14%)	--	--	1.91 (14%)	--	--	15.16 (19%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.15 (14%)	--	--	1.91 (14%)	--	--	15.16 (19%)

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	37.7	0.0	0.6	13.9	0.0	2.9	78.7
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	32.5	0.0	0.6	12.0	0.0	2.9	63.6
Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**											
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.15 (14%)	--	0.00 (0%)	1.91 (14%)	--	0.00 (0%)	15.16 (19%)
Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**											
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.15 (14%)	--	0.00 (0%)	1.91 (14%)	--	0.00 (0%)	15.16 (19%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 HVAC | Run Date/Time: 12/29/09 @ 14:06

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	1,376.9	0.0	0.0	59.0	0.0	0.0	29.9	0.0	1,465.8
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	1,033.3	0.0	0.0	62.1	0.0	0.0	29.7	0.0	1,125.1

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	343.58 (25%)	--	--	-3.08 (-5%)	--	--	0.13 (0%)	--	340.63 (23%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	343.58 (25%)	--	--	-3.08 (-5%)	--	--	0.13 (0%)	--	340.63 (23%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 HVAC — Run Date/Time: 12/29/09 @ 14:13

Annual Electric Energy by Enduse (pg 1 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (kWh)											
0 Base Design	58,412	3,644	24,585	0	26,291	0	1,944	73,229	0	10,473	198,578
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	22,654	0	1,935	64,090	0	10,473	160,896

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.64 (14%)	--	0.01 (0%)	9.14 (12%)	--	0.00 (0%)	37.68 (19%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.64 (14%)	--	0.01 (0%)	9.14 (12%)	--	0.00 (0%)	37.68 (19%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 HVAC | Run Date/Time: 12/29/09 @ 14:13

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)												
0	Base Design	19.0	1.4	6.7	0.0	31.6	0.0	0.0	13.0	0.0	0.0	71.8
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	26.7	0.0	0.0	12.2	0.0	0.0	57.9

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.90 (16%)	--	--	0.81 (6%)	--	--	13.81 (19%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.90 (16%)	--	--	0.81 (6%)	--	--	13.81 (19%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 HVAC   Run Date/Time: 12/29/09 @ 14:13

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	31.6	0.0	0.6	13.0	0.0	2.9	71.8
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	26.7	0.0	0.6	12.2	0.0	2.9	57.9

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.90 (16%)	--	0.00 (0%)	0.81 (6%)	--	0.00 (0%)	13.81 (19%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.90 (16%)	--	0.00 (0%)	0.81 (6%)	--	0.00 (0%)	13.81 (19%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 HVAC   Run Date/Time: 12/29/09 @ 14:13

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	788.8	0.0	0.0	64.5	0.0	0.0	28.2	0.0	881.5
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	562.8	0.0	0.0	67.7	0.0	0.0	28.1	0.0	658.6

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	226.05 (29%)	--	--	-3.14 (-5%)	--	--	0.08 (0%)	--	222.99 (25%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	226.05 (29%)	--	--	-3.14 (-5%)	--	--	0.08 (0%)	--	222.99 (25%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 HVAC   Run Date/Time: 12/29/09 @ 14:20

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	36,363	0	1,336	69,623	0	10,473	204,435
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	30,119	0	1,334	58,388	0	10,473	162,057

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	6.24 (17%)	--	0.00 (0%)	11.23 (16%)	--	0.00 (0%)	42.38 (21%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	6.24 (17%)	--	0.00 (0%)	11.23 (16%)	--	0.00 (0%)	42.38 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 HVAC | Run Date/Time: 12/29/09 @ 14:20

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	37.0	0.0	0.0	13.1	0.0	0.0	77.2
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	32.2	0.0	0.0	11.9	0.0	0.0	63.1

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.73 (13%)	--	--	1.20 (9%)	--	--	14.03 (18%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.73 (13%)	--	--	1.20 (9%)	--	--	14.03 (18%)

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	37.0	0.0	0.6	13.1	0.0	2.9	77.2
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	32.2	0.0	0.6	11.9	0.0	2.9	63.1
Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**											
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.73 (13%)	--	0.00 (0%)	1.20 (9%)	--	0.00 (0%)	14.03 (18%)
Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**											
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.73 (13%)	--	0.00 (0%)	1.20 (9%)	--	0.00 (0%)	14.03 (18%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 HVAC | Run Date/Time: 12/29/09 @ 14:20

Annual Fuel Energy by Enduse (pg 4 of 4)

		Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)											
0	Base Design	0.0	600.5	0.0	0.0	67.5	0.0	0.0	27.0	0.0	695.1
1	0+DG Window	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	0.0	438.7	0.0	0.0	69.8	0.0	0.0	27.0	0.0	535.5

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

		Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	--	161.88 (27%)	--	--	-2.27 (-3%)	--	--	0.04 (0%)	--	159.65 (23%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

		Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	--	161.88 (27%)	--	--	-2.27 (-3%)	--	--	0.04 (0%)	--	159.65 (23%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 HVAC

Run Date/Time: 12/29/09 @ 14:26

Annual Electric Energy by Enduse (pg 1 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (kWh)											
0 Base Design	58,412	3,644	24,585	0	69,961	0	213	58,890	0	10,473	226,177
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	56,886	0	213	49,092	0	10,473	178,407

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	13.08 (19%)	--	0.00 (0%)	9.80 (17%)	--	0.00 (0%)	47.77 (21%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	13.08 (19%)	--	0.00 (0%)	9.80 (17%)	--	0.00 (0%)	47.77 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 HVAC | Run Date/Time: 12/29/09 @ 14:26

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	38.0	0.0	0.0	12.5	0.0	0.0	77.7
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	32.0	0.0	0.0	11.3	0.0	0.0	62.4

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.99 (16%)	--	--	1.20 (10%)	--	--	15.29 (20%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.99 (16%)	--	--	1.20 (10%)	--	--	15.29 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 HVAC

Run Date/Time: 12/29/09 @ 14:26

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0	Base Design	19.0	1.4	6.7	0.0	38.0	0.0	0.6	12.5	0.0	2.9	77.7
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	32.0	0.0	0.6	11.3	0.0	2.9	62.4

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.99 (16%)	--	0.00 (0%)	1.20 (10%)	--	0.00 (0%)	15.29 (20%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.99 (16%)	--	0.00 (0%)	1.20 (10%)	--	0.00 (0%)	15.29 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 HVAC   Run Date/Time: 12/29/09 @ 14:26

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	78.0	0.0	0.0	75.6	0.0	0.0	24.1	0.0	177.8
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	63.4	0.0	0.0	75.8	0.0	0.0	24.1	0.0	163.4

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	14.59 (19%)	--	--	-0.22 (-0%)	--	--	-0.01 (-0%)	--	14.37 (8%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	14.59 (19%)	--	--	-0.22 (-0%)	--	--	-0.01 (-0%)	--	14.37 (8%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 (N_S) Run Date/Time: 12/05/09 @ 17:54

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	16,535	0	10,260	278,412	0	10,473	402,321
1 0+DG Window	58,412	3,644	24,585	0	15,318	0	9,589	258,538	0	10,473	380,560
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	16,623	0	10,260	279,266	0	10,473	403,264
3 0+LPD	33,514	3,644	24,585	0	16,084	0	10,111	273,371	0	10,473	371,781
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	16,605	0	9,655	268,960	0	10,473	392,333
5 0+Combo of ECMs	33,514	3,644	24,585	0	14,548	0	8,637	239,388	0	10,473	334,787

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.22 (7%)	--	0.67 (7%)	19.87 (7%)	--	0.00 (0%)	21.76 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.09 (-1%)	--	0.00 (0%)	-0.85 (-0%)	--	0.00 (0%)	-0.94 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.45 (3%)	--	0.15 (1%)	5.04 (2%)	--	0.00 (0%)	30.54 (8%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.07 (-0%)	--	0.61 (6%)	9.45 (3%)	--	0.00 (0%)	9.99 (2%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.99 (12%)	--	1.62 (16%)	39.02 (14%)	--	0.00 (0%)	67.53 (17%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.22 (7%)	--	0.67 (7%)	19.87 (7%)	--	0.00 (0%)	21.76 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.09 (-1%)	--	0.00 (0%)	-0.85 (-0%)	--	0.00 (0%)	-0.94 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.45 (3%)	--	0.15 (1%)	5.04 (2%)	--	0.00 (0%)	30.54 (8%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.07 (-0%)	--	0.61 (6%)	9.45 (3%)	--	0.00 (0%)	9.99 (2%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.99 (12%)	--	1.62 (16%)	39.02 (14%)	--	0.00 (0%)	67.53 (17%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 (N_S) Run Date/Time: 12/05/09 @ 17:54

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)												
0	Base Design	19.0	1.4	6.7	0.0	3.7	0.0	1.2	34.4	0.0	0.0	66.4
1	0+DG Window	19.0	1.4	6.7	0.0	3.4	0.0	1.1	31.5	0.0	0.0	63.1
2	0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.7	0.0	1.2	34.4	0.0	0.0	66.4
3	0+LPD	10.9	1.4	6.7	0.0	3.6	0.0	1.2	33.8	0.0	0.0	57.5
4	0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.8	0.0	1.1	32.4	0.0	0.0	64.4
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	3.2	0.0	1.0	28.6	0.0	0.0	51.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.33 (9%)	--	0.08 (7%)	2.85 (8%)	--	--	3.26 (5%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.16 (4%)	--	0.02 (1%)	0.56 (2%)	--	--	8.84 (13%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.12 (-3%)	--	0.07 (6%)	2.00 (6%)	--	--	1.95 (3%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.48 (13%)	--	0.19 (16%)	5.80 (17%)	--	--	14.57 (22%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.33 (9%)	--	0.08 (7%)	2.85 (8%)	--	--	3.26 (5%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.16 (4%)	--	0.02 (1%)	0.56 (2%)	--	--	8.84 (13%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.12 (-3%)	--	0.07 (6%)	2.00 (6%)	--	--	1.95 (3%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.48 (13%)	--	0.19 (16%)	5.80 (17%)	--	--	14.57 (22%)

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)												
0	Base Design	19.0	1.4	6.7	0.0	3.7	0.0	1.2	34.4	0.0	2.9	66.4
1	0+DG Window	19.0	1.4	6.7	0.0	3.4	0.0	1.1	31.5	0.0	2.9	63.1
2	0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.7	0.0	1.2	34.4	0.0	2.9	66.4
3	0+LPD	10.9	1.4	6.7	0.0	3.6	0.0	1.2	33.8	0.0	2.9	57.5
4	0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.9	0.0	1.1	32.4	0.0	2.9	64.4
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	3.3	0.0	1.0	28.6	0.0	2.9	51.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.33 (9%)	--	0.08 (7%)	2.86 (8%)	--	0.00 (0%)	3.26 (5%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (4%)	--	0.02 (1%)	0.56 (2%)	--	0.00 (0%)	8.84 (13%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.12 (-3%)	--	0.07 (6%)	2.01 (6%)	--	0.00 (0%)	1.95 (3%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.47 (13%)	--	0.19 (16%)	5.83 (17%)	--	0.00 (0%)	14.57 (22%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.33 (9%)	--	0.08 (7%)	2.86 (8%)	--	0.00 (0%)	3.26 (5%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (4%)	--	0.02 (1%)	0.56 (2%)	--	0.00 (0%)	8.84 (13%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.12 (-3%)	--	0.07 (6%)	2.01 (6%)	--	0.00 (0%)	1.95 (3%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.47 (13%)	--	0.19 (16%)	5.83 (17%)	--	0.00 (0%)	14.57 (22%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 (N_S) Run Date/Time: 12/05/09 @ 17:54

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.1	0.0	29.1
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.1	0.0	29.1
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.1	0.0	29.1
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.1	0.0	29.1
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0	0.0	29.0
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.9	0.0	28.9

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.09 (0%)	--	0.09 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.12 (0%)	--	0.12 (0%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.24 (1%)	--	0.24 (1%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.09 (0%)	--	0.09 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.12 (0%)	--	0.12 (0%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.24 (1%)	--	0.24 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 (N_S) Run Date/Time: 12/05/09 @ 17:15

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	20,284	0	10,662	294,769	0	10,473	422,830
1 0+DG Window	58,412	3,644	24,585	0	18,567	0	9,800	270,898	0	10,473	396,379
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	20,341	0	10,662	295,391	0	10,473	423,510
3 0+LPD	33,514	3,644	24,585	0	19,685	0	10,508	289,167	0	10,473	391,576
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	19,824	0	9,875	277,631	0	10,473	404,443
5 0+Combo of ECMs	33,514	3,644	24,585	0	17,008	0	8,719	243,636	0	10,473	341,579

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.72 (8%)	--	0.86 (8%)	23.87 (8%)	--	0.00 (0%)	26.45 (6%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.06 (-0%)	--	0.00 (0%)	-0.62 (-0%)	--	0.00 (0%)	-0.68 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.60 (3%)	--	0.15 (1%)	5.60 (2%)	--	0.00 (0%)	31.25 (7%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.46 (2%)	--	0.79 (7%)	17.14 (6%)	--	0.00 (0%)	18.39 (4%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.28 (16%)	--	1.94 (18%)	51.13 (17%)	--	0.00 (0%)	81.25 (19%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.72 (8%)	--	0.86 (8%)	23.87 (8%)	--	0.00 (0%)	26.45 (6%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.06 (-0%)	--	0.00 (0%)	-0.62 (-0%)	--	0.00 (0%)	-0.68 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.60 (3%)	--	0.15 (1%)	5.60 (2%)	--	0.00 (0%)	31.25 (7%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.46 (2%)	--	0.79 (7%)	17.14 (6%)	--	0.00 (0%)	18.39 (4%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.28 (16%)	--	1.94 (18%)	51.13 (17%)	--	0.00 (0%)	81.25 (19%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 (N_S) Run Date/Time: 12/05/09 @ 17:15

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	4.2	0.0	1.2	35.8	0.0	0.0	68.3
1 0+DG Window	19.0	1.4	6.7	0.0	3.8	0.0	1.1	32.5	0.0	0.0	64.6
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	4.2	0.0	1.2	35.8	0.0	0.0	68.3
3 0+LPD	10.9	1.4	6.7	0.0	4.0	0.0	1.2	35.2	0.0	0.0	59.4
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	4.2	0.0	1.1	33.0	0.0	0.0	65.5
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	3.5	0.0	1.0	28.8	0.0	0.0	52.3

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.41 (10%)	--	0.10 (8%)	3.23 (9%)	--	--	3.73 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.17 (4%)	--	0.02 (1%)	0.58 (2%)	--	--	8.87 (13%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.06 (-1%)	--	0.09 (7%)	2.76 (8%)	--	--	2.78 (4%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.66 (16%)	--	0.22 (18%)	7.00 (20%)	--	--	15.98 (23%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.41 (10%)	--	0.10 (8%)	3.23 (9%)	--	--	3.73 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.17 (4%)	--	0.02 (1%)	0.58 (2%)	--	--	8.87 (13%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.06 (-1%)	--	0.09 (7%)	2.76 (8%)	--	--	2.78 (4%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.66 (16%)	--	0.22 (18%)	7.00 (20%)	--	--	15.98 (23%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 (N_S) Run Date/Time: 12/05/09 @ 17:15

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	4.2	0.0	1.2	35.8	0.0	2.9	68.3
1 0+DG Window	19.0	1.4	6.7	0.0	3.8	0.0	1.1	32.5	0.0	2.9	64.6
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	4.2	0.0	1.2	35.8	0.0	2.9	68.3
3 0+LPD	10.9	1.4	6.7	0.0	4.0	0.0	1.2	35.2	0.0	2.9	59.4
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	4.2	0.0	1.1	33.0	0.0	2.9	65.5
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	3.5	0.0	1.0	28.8	0.0	2.9	52.3

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.41 (10%)	--	0.10 (8%)	3.25 (9%)	--	0.00 (0%)	3.73 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	-0.01 (-0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.17 (4%)	--	0.02 (1%)	0.58 (2%)	--	0.00 (0%)	8.87 (13%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.06 (-1%)	--	0.09 (7%)	2.78 (8%)	--	0.00 (0%)	2.78 (4%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.66 (16%)	--	0.22 (18%)	7.02 (20%)	--	0.00 (0%)	15.98 (23%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.41 (10%)	--	0.10 (8%)	3.25 (9%)	--	0.00 (0%)	3.73 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	-0.01 (-0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.17 (4%)	--	0.02 (1%)	0.58 (2%)	--	0.00 (0%)	8.87 (13%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.06 (-1%)	--	0.09 (7%)	2.78 (8%)	--	0.00 (0%)	2.78 (4%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.66 (16%)	--	0.22 (18%)	7.02 (20%)	--	0.00 (0%)	15.98 (23%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 (N_S) Run Date/Time: 12/05/09 @ 17:15

Annual Fuel Energy by Enduse (pg 4 of 4)

		Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)											
0	Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.6	0.0	27.6
1	0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.6	0.0	27.6
2	0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.6	0.0	27.6
3	0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.6	0.0	27.6
4	0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.5	0.0	27.5
5	0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.5	0.0	27.5
Incremental SAVINGS (MBtu)	**(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**										
1	0+DG Window	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.04 (0%)	--	0.04 (0%)
3	0+LPD	--	--	--	--	--	--	--	-0.00 (-0%)	--	-0.00 (-0%)
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.11 (0%)	--	0.11 (0%)
5	0+Combo of ECMs	--	--	--	--	--	--	--	0.16 (1%)	--	0.16 (1%)
Cumulative SAVINGS (MBtu)	**(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**										
1	0+DG Window	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.04 (0%)	--	0.04 (0%)
3	0+LPD	--	--	--	--	--	--	--	-0.00 (-0%)	--	-0.00 (-0%)
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.11 (0%)	--	0.11 (0%)
5	0+Combo of ECMs	--	--	--	--	--	--	--	0.16 (1%)	--	0.16 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 (N_S) Run Date/Time: 12/05/09 @ 17:41

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	14,532	0	8,396	239,344	0	10,473	359,387
1 0+DG Window	58,412	3,644	24,585	0	13,552	0	7,831	223,399	0	10,473	341,895
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	14,560	0	8,396	239,815	0	10,473	359,886
3 0+LPD	33,514	3,644	24,585	0	14,055	0	8,239	234,449	0	10,473	328,959
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	15,517	0	8,295	242,770	0	10,473	363,696
5 0+Combo of ECMs	33,514	3,644	24,585	0	13,605	0	7,472	216,977	0	10,473	310,270

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.98 (7%)	--	0.57 (7%)	15.95 (7%)	--	0.00 (0%)	17.49 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.03 (-0%)	--	0.00 (0%)	-0.47 (-0%)	--	0.00 (0%)	-0.50 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.48 (3%)	--	0.16 (2%)	4.89 (2%)	--	0.00 (0%)	30.43 (8%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.98 (-7%)	--	0.10 (1%)	-3.43 (-1%)	--	0.00 (0%)	-4.31 (-1%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.93 (6%)	--	0.92 (11%)	22.37 (9%)	--	0.00 (0%)	49.12 (14%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.98 (7%)	--	0.57 (7%)	15.95 (7%)	--	0.00 (0%)	17.49 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.03 (-0%)	--	0.00 (0%)	-0.47 (-0%)	--	0.00 (0%)	-0.50 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.48 (3%)	--	0.16 (2%)	4.89 (2%)	--	0.00 (0%)	30.43 (8%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.98 (-7%)	--	0.10 (1%)	-3.43 (-1%)	--	0.00 (0%)	-4.31 (-1%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.93 (6%)	--	0.92 (11%)	22.37 (9%)	--	0.00 (0%)	49.12 (14%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 (N_S) Run Date/Time: 12/05/09 @ 17:41

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

Annual Energy Coincident Demand (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	3.3	0.0	1.0	28.7	0.0	0.0	60.1
1 0+DG Window	19.0	1.4	6.7	0.0	3.0	0.0	0.9	26.6	0.0	0.0	57.7
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.2	0.0	1.0	28.7	0.0	0.0	60.1
3 0+LPD	10.9	1.4	6.7	0.0	3.1	0.0	0.9	28.2	0.0	0.0	51.3
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.5	0.0	0.9	28.5	0.0	0.0	60.1
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	3.0	0.0	0.9	25.4	0.0	0.0	48.3

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

Incremental SAVINGS (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.06 (7%)	2.12 (7%)	--	--	2.43 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	--	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.14 (4%)	--	0.02 (2%)	0.54 (2%)	--	--	8.81 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.26 (-8%)	--	0.01 (1%)	0.22 (1%)	--	--	-0.03 (-0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.24 (7%)	--	0.11 (11%)	3.34 (12%)	--	--	11.80 (20%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

Cumulative SAVINGS (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.06 (7%)	2.12 (7%)	--	--	2.43 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	--	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.14 (4%)	--	0.02 (2%)	0.54 (2%)	--	--	8.81 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.26 (-8%)	--	0.01 (1%)	0.22 (1%)	--	--	-0.03 (-0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.24 (7%)	--	0.11 (11%)	3.34 (12%)	--	--	11.80 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 (N_S) Run Date/Time: 12/05/09 @ 17:41

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0	Base Design	19.0	1.4	6.7	0.0	3.3	0.0	1.0	28.7	0.0	2.9	60.1
1	0+DG Window	19.0	1.4	6.7	0.0	3.0	0.0	0.9	26.6	0.0	2.9	57.7
2	0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.2	0.0	1.0	28.7	0.0	2.9	60.1
3	0+LPD	10.9	1.4	6.7	0.0	3.1	0.0	0.9	28.2	0.0	2.9	51.3
4	0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.5	0.0	0.9	28.5	0.0	2.9	60.1
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	3.0	0.0	0.9	25.4	0.0	2.9	48.3

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.06 (7%)	2.12 (7%)	--	0.00 (0%)	2.43 (4%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.02 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.14 (4%)	--	0.02 (2%)	0.53 (2%)	--	0.00 (0%)	8.81 (15%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.27 (-8%)	--	0.01 (1%)	0.22 (1%)	--	0.00 (0%)	-0.03 (-0%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.22 (7%)	--	0.11 (11%)	3.35 (12%)	--	0.00 (0%)	11.80 (20%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.06 (7%)	2.12 (7%)	--	0.00 (0%)	2.43 (4%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.02 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.14 (4%)	--	0.02 (2%)	0.53 (2%)	--	0.00 (0%)	8.81 (15%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.27 (-8%)	--	0.01 (1%)	0.22 (1%)	--	0.00 (0%)	-0.03 (-0%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.22 (7%)	--	0.11 (11%)	3.35 (12%)	--	0.00 (0%)	11.80 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 (N_S) Run Date/Time: 12/05/09 @ 17:41

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.1	0.0	26.1
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0	0.0	26.0
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0	0.0	26.0
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.1	0.0	26.1
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.9	0.0	25.9
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.8	0.0	25.8

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.02 (0%)	--	0.02 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.03 (0%)	--	0.03 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.17 (1%)	--	0.17 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.25 (1%)	--	0.25 (1%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.02 (0%)	--	0.02 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.03 (0%)	--	0.03 (0%)
3 0+LPD	--	--	--	--	--	--	--	0.00 (0%)	--	0.00 (0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.17 (1%)	--	0.17 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.25 (1%)	--	0.25 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 (N_S) | Run Date/Time: 12/05/09 @ 17:24

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	16,911	0	8,302	241,043	0	10,473	363,369
1 0+DG Window	58,412	3,644	24,585	0	15,747	0	7,727	224,841	0	10,473	345,429
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	16,946	0	8,302	241,595	0	10,473	363,957
3 0+LPD	33,514	3,644	24,585	0	16,303	0	8,129	235,340	0	10,473	331,987
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	17,521	0	8,137	239,105	0	10,473	361,876
5 0+Combo of ECMs	33,514	3,644	24,585	0	15,312	0	7,304	213,480	0	10,473	308,313

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.16 (7%)	--	0.58 (7%)	16.20 (7%)	--	0.00 (0%)	17.94 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.04 (-0%)	--	0.00 (0%)	-0.55 (-0%)	--	0.00 (0%)	-0.59 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.61 (4%)	--	0.17 (2%)	5.70 (2%)	--	0.00 (0%)	31.38 (9%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.61 (-4%)	--	0.17 (2%)	1.94 (1%)	--	0.00 (0%)	1.49 (0%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.60 (9%)	--	1.00 (12%)	27.56 (11%)	--	0.00 (0%)	55.06 (15%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.16 (7%)	--	0.58 (7%)	16.20 (7%)	--	0.00 (0%)	17.94 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.04 (-0%)	--	0.00 (0%)	-0.55 (-0%)	--	0.00 (0%)	-0.59 (-0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.61 (4%)	--	0.17 (2%)	5.70 (2%)	--	0.00 (0%)	31.38 (9%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.61 (-4%)	--	0.17 (2%)	1.94 (1%)	--	0.00 (0%)	1.49 (0%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.60 (9%)	--	1.00 (12%)	27.56 (11%)	--	0.00 (0%)	55.06 (15%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 (N_S) Run Date/Time: 12/05/09 @ 17:24

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

Annual Energy Coincident Demand (kW)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	3.1	0.0	0.9	28.5	0.0	0.0	59.7
1 0+DG Window	19.0	1.4	6.7	0.0	2.9	0.0	0.9	26.3	0.0	0.0	57.2
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.1	0.0	0.9	28.5	0.0	0.0	59.7
3 0+LPD	10.9	1.4	6.7	0.0	3.0	0.0	0.9	27.8	0.0	0.0	50.8
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.4	0.0	0.9	27.9	0.0	0.0	59.3
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.8	0.0	0.8	24.8	0.0	0.0	47.5

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.15 (8%)	--	--	2.47 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	-0.00 (-0%)	--	--	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (5%)	--	0.02 (2%)	0.65 (2%)	--	--	8.93 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.25 (-8%)	--	0.02 (2%)	0.60 (2%)	--	--	0.37 (1%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.27 (9%)	--	0.11 (12%)	3.71 (13%)	--	--	12.20 (20%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.15 (8%)	--	--	2.47 (4%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	-0.00 (-0%)	--	--	0.02 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (5%)	--	0.02 (2%)	0.65 (2%)	--	--	8.93 (15%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.25 (-8%)	--	0.02 (2%)	0.60 (2%)	--	--	0.37 (1%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.27 (9%)	--	0.11 (12%)	3.71 (13%)	--	--	12.20 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 (N_S) Run Date/Time: 12/05/09 @ 17:24

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0	Base Design	19.0	1.4	6.7	0.0	3.2	0.0	0.9	28.5	0.0	2.9	59.7
1	0+DG Window	19.0	1.4	6.7	0.0	2.9	0.0	0.9	26.3	0.0	2.9	57.2
2	0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	3.1	0.0	0.9	28.5	0.0	2.9	59.7
3	0+LPD	10.9	1.4	6.7	0.0	3.1	0.0	0.9	27.9	0.0	2.9	50.8
4	0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	3.4	0.0	0.9	27.9	0.0	2.9	59.3
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	2.9	0.0	0.8	24.8	0.0	2.9	47.5

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.15 (8%)	--	0.00 (0%)	2.47 (4%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	-0.00 (-0%)	--	0.00 (0%)	0.02 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.11 (3%)	--	0.02 (2%)	0.65 (2%)	--	0.00 (0%)	8.93 (15%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.19 (-6%)	--	0.02 (2%)	0.60 (2%)	--	0.00 (0%)	0.37 (1%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.29 (9%)	--	0.11 (12%)	3.71 (13%)	--	0.00 (0%)	12.20 (20%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.25 (8%)	--	0.07 (7%)	2.15 (8%)	--	0.00 (0%)	2.47 (4%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.02 (1%)	--	0.00 (0%)	-0.00 (-0%)	--	0.00 (0%)	0.02 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.11 (3%)	--	0.02 (2%)	0.65 (2%)	--	0.00 (0%)	8.93 (15%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.19 (-6%)	--	0.02 (2%)	0.60 (2%)	--	0.00 (0%)	0.37 (1%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.29 (9%)	--	0.11 (12%)	3.71 (13%)	--	0.00 (0%)	12.20 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 (N_S) Run Date/Time: 12/05/09 @ 17:24

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.8	0.0	24.8
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.8	0.0	24.8
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.8	0.0	24.8
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.8	0.0	24.8
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.7	0.0	24.7
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.7	0.0	24.7

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.02 (0%)	--	0.02 (0%)
3 0+LPD	--	--	--	--	--	--	--	-0.00 (-0%)	--	-0.00 (-0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.15 (1%)	--	0.15 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.19 (1%)	--	0.19 (1%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.02 (0%)	--	0.02 (0%)
3 0+LPD	--	--	--	--	--	--	--	-0.00 (-0%)	--	-0.00 (-0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.15 (1%)	--	0.15 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.19 (1%)	--	0.19 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 (N_S) Run Date/Time: 12/05/09 @ 17:05

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	15,796	0	6,790	206,418	0	10,473	326,118
1 0+DG Window	58,412	3,644	24,585	0	14,710	0	6,349	192,219	0	10,473	310,391
2 0+R-38 Roof Insulation	58,412	3,644	24,585	0	15,791	0	6,790	206,418	0	10,473	326,112
3 0+LPD	33,514	3,644	24,585	0	15,050	0	6,583	199,641	0	10,473	293,491
4 0+R-19 Wall Insulation	58,412	3,644	24,585	0	16,283	0	6,698	203,742	0	10,473	323,838
5 0+Combo of ECMs	33,514	3,644	24,585	0	14,100	0	6,085	180,495	0	10,473	272,897

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.09 (7%)	--	0.44 (6%)	14.20 (7%)	--	0.00 (0%)	15.73 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.75 (5%)	--	0.21 (3%)	6.78 (3%)	--	0.00 (0%)	32.63 (10%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.49 (-3%)	--	0.09 (1%)	2.68 (1%)	--	0.00 (0%)	2.28 (1%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.70 (11%)	--	0.71 (10%)	25.92 (13%)	--	0.00 (0%)	53.22 (16%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	1.09 (7%)	--	0.44 (6%)	14.20 (7%)	--	0.00 (0%)	15.73 (5%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3 0+LPD	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.75 (5%)	--	0.21 (3%)	6.78 (3%)	--	0.00 (0%)	32.63 (10%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.49 (-3%)	--	0.09 (1%)	2.68 (1%)	--	0.00 (0%)	2.28 (1%)
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	1.70 (11%)	--	0.71 (10%)	25.92 (13%)	--	0.00 (0%)	53.22 (16%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 (N_S) Run Date/Time: 12/05/09 @ 17:05

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	2.7	0.0	0.8	23.7	0.0	0.0	54.3
1 0+DG Window	19.0	1.4	6.7	0.0	2.5	0.0	0.7	22.1	0.0	0.0	52.4
2 0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	2.6	0.0	0.8	23.7	0.0	0.0	54.3
3 0+LPD	10.9	1.4	6.7	0.0	2.5	0.0	0.8	22.9	0.0	0.0	45.2
4 0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	2.8	0.0	0.8	23.4	0.0	0.0	54.1
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	2.4	0.0	0.7	20.7	0.0	0.0	42.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.19 (7%)	--	0.05 (6%)	1.65 (7%)	--	--	1.89 (3%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (6%)	--	0.02 (3%)	0.77 (3%)	--	--	9.05 (17%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.18 (-7%)	--	0.01 (1%)	0.32 (1%)	--	--	0.15 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.25 (9%)	--	0.08 (10%)	3.02 (13%)	--	--	11.46 (21%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.19 (7%)	--	0.05 (6%)	1.65 (7%)	--	--	1.89 (3%)
2 0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	--	0.01 (0%)
3 0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (6%)	--	0.02 (3%)	0.77 (3%)	--	--	9.05 (17%)
4 0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.18 (-7%)	--	0.01 (1%)	0.32 (1%)	--	--	0.15 (0%)
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.25 (9%)	--	0.08 (10%)	3.02 (13%)	--	--	11.46 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 (N_S) Run Date/Time: 12/05/09 @ 17:05

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0	Base Design	19.0	1.4	6.7	0.0	2.7	0.0	0.8	23.7	0.0	2.9	54.3
1	0+DG Window	19.0	1.4	6.7	0.0	2.5	0.0	0.7	22.1	0.0	2.9	52.4
2	0+R-38 Roof Insulation	19.0	1.4	6.7	0.0	2.7	0.0	0.8	23.7	0.0	2.9	54.3
3	0+LPD	10.9	1.4	6.7	0.0	2.6	0.0	0.8	22.9	0.0	2.9	45.2
4	0+R-19 Wall Insulation	19.0	1.4	6.7	0.0	2.9	0.0	0.8	23.4	0.0	2.9	54.1
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	2.5	0.0	0.7	20.7	0.0	2.9	42.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.19 (7%)	--	0.05 (6%)	1.65 (7%)	--	0.00 (0%)	1.89 (3%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (6%)	--	0.02 (3%)	0.77 (3%)	--	0.00 (0%)	9.05 (17%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.18 (-7%)	--	0.01 (1%)	0.31 (1%)	--	0.00 (0%)	0.15 (0%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.26 (9%)	--	0.08 (10%)	3.02 (13%)	--	0.00 (0%)	11.46 (21%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.19 (7%)	--	0.05 (6%)	1.65 (7%)	--	0.00 (0%)	1.89 (3%)
2	0+R-38 Roof Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	0.01 (0%)	--	0.00 (0%)	0.00 (0%)	--	0.00 (0%)	0.01 (0%)
3	0+LPD	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.15 (6%)	--	0.02 (3%)	0.77 (3%)	--	0.00 (0%)	9.05 (17%)
4	0+R-19 Wall Insulation	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	-0.18 (-7%)	--	0.01 (1%)	0.31 (1%)	--	0.00 (0%)	0.15 (0%)
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	0.26 (9%)	--	0.08 (10%)	3.02 (13%)	--	0.00 (0%)	11.46 (21%)

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9	0.0	21.9
1 0+DG Window	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9	0.0	21.9
2 0+R-38 Roof Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9	0.0	21.9
3 0+LPD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9	0.0	21.9
4 0+R-19 Wall Insulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8	0.0	21.8
5 0+Combo of ECMs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.7	0.0	21.7
Incremental SAVINGS (MBtu) (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)										
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
3 0+LPD	--	--	--	--	--	--	--	-0.00 (-0%)	--	-0.00 (-0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.15 (1%)	--	0.15 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.17 (1%)	--	0.17 (1%)
Cumulative SAVINGS (MBtu) (values (and % savings) are relative to the Base Case, negative entries indicate increased use)										
1 0+DG Window	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	0.01 (0%)	--	0.01 (0%)
3 0+LPD	--	--	--	--	--	--	--	-0.00 (-0%)	--	-0.00 (-0%)
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	0.15 (1%)	--	0.15 (1%)
5 0+Combo of ECMs	--	--	--	--	--	--	--	0.17 (1%)	--	0.17 (1%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 (N_S) HVAC — Run Date/Time: 12/29/09 @ 14:38

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	11,550	0	2,924	91,054	0	10,473	202,641
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	10,839	0	2,923	80,519	0	10,473	166,497

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.71 (6%)	--	0.00 (0%)	10.53 (12%)	--	0.00 (0%)	36.14 (18%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	0.71 (6%)	--	0.00 (0%)	10.53 (12%)	--	0.00 (0%)	36.14 (18%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 (N_S) HVAC

Run Date/Time: 12/29/09 @ 14:38

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	28.2	0.0	0.0	14.5	0.0	0.0	69.8
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	25.2	0.0	0.0	13.6	0.0	0.0	57.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	3.00 (11%)	--	--	0.94 (7%)	--	--	12.05 (17%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	3.00 (11%)	--	--	0.94 (7%)	--	--	12.05 (17%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 (N_S) HVAC   Run Date/Time: 12/29/09 @ 14:38

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	28.2	0.0	0.6	14.5	0.0	2.9	69.8
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	25.2	0.0	0.6	13.6	0.0	2.9	57.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	3.07 (11%)	--	0.00 (0%)	0.94 (7%)	--	0.00 (0%)	12.05 (17%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	3.07 (11%)	--	0.00 (0%)	0.94 (7%)	--	0.00 (0%)	12.05 (17%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C1 (N_S) HVAC | Run Date/Time: 12/29/09 @ 14:38

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	1,539.8	0.0	0.0	57.2	0.0	0.0	31.2	0.0	1,628.2
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	1,122.4	0.0	0.0	61.8	0.0	0.0	31.0	0.0	1,215.2

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	417.41 (27%)	--	--	-4.62 (-8%)	--	--	0.18 (1%)	--	412.98 (25%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	417.41 (27%)	--	--	-4.62 (-8%)	--	--	0.18 (1%)	--	412.98 (25%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 (N_S) HVAC | Run Date/Time: 12/29/09 @ 14:45

Annual Electric Energy by Enduse (pg 1 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (kWh)											
0 Base Design	58,412	3,644	24,585	0	25,829	0	2,300	90,139	0	10,473	215,382
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	21,997	0	2,299	75,614	0	10,473	172,126

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.83 (15%)	--	0.00 (0%)	14.53 (16%)	--	0.00 (0%)	43.26 (20%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	3.83 (15%)	--	0.00 (0%)	14.53 (16%)	--	0.00 (0%)	43.26 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 (N_S) HVAC | Run Date/Time: 12/29/09 @ 14:45

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	38.1	0.0	0.0	14.9	0.0	0.0	80.2
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	33.6	0.0	0.0	13.2	0.0	0.0	65.8
Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**											
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.56 (12%)	--	--	1.67 (11%)	--	--	14.34 (18%)
Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**											
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.56 (12%)	--	--	1.67 (11%)	--	--	14.34 (18%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 (N_S) HVAC Run Date/Time: 12/29/09 @ 14:45

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)											
0 Base Design	19.0	1.4	6.7	0.0	38.1	0.0	0.6	14.9	0.0	2.9	80.2
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	33.6	0.0	0.6	13.2	0.0	2.9	65.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.56 (12%)	--	0.00 (0%)	1.67 (11%)	--	0.00 (0%)	14.34 (18%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.56 (12%)	--	0.00 (0%)	1.67 (11%)	--	0.00 (0%)	14.34 (18%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C2 (N_S) HVAC   Run Date/Time: 12/29/09 @ 14:45

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	1,394.9	0.0	0.0	59.6	0.0	0.0	29.8	0.0	1,484.3
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	1,042.6	0.0	0.0	62.9	0.0	0.0	29.7	0.0	1,135.1

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	352.35 (25%)	--	--	-3.29 (-6%)	--	--	0.12 (0%)	--	349.18 (24%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	352.35 (25%)	--	--	-3.29 (-6%)	--	--	0.12 (0%)	--	349.18 (24%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 (N_S) HVAC | Run Date/Time: 12/29/09 @ 14:51

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	32,373	0	1,947	81,123	0	10,473	212,557
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	27,542	0	1,944	71,715	0	10,473	173,417

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	4.83 (15%)	--	0.00 (0%)	9.41 (12%)	--	0.00 (0%)	39.14 (18%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	4.83 (15%)	--	0.00 (0%)	9.41 (12%)	--	0.00 (0%)	39.14 (18%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 (N_S) HVAC   Run Date/Time: 12/29/09 @ 14:51

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

Annual Energy Coincident Demand (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	34.1	0.0	0.0	14.4	0.0	0.0	75.7
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	28.3	0.0	0.0	13.8	0.0	0.0	61.2

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

Incremental SAVINGS (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.83 (17%)	--	--	0.62 (4%)	--	--	14.56 (19%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

Cumulative SAVINGS (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.83 (17%)	--	--	0.62 (4%)	--	--	14.56 (19%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 (N_S) HVAC | Run Date/Time: 12/29/09 @ 14:51

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0	Base Design	19.0	1.4	6.7	0.0	34.1	0.0	0.6	14.4	0.0	2.9	75.7
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	10.9	1.4	6.7	0.0	28.8	0.0	0.6	13.8	0.0	2.9	61.2

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.29 (15%)	--	0.00 (0%)	0.62 (4%)	--	0.00 (0%)	14.56 (19%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2	0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3	0+LPD	--	--	--	--	--	--	--	--	--	--	--
4	0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5	0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	5.29 (15%)	--	0.00 (0%)	0.62 (4%)	--	0.00 (0%)	14.56 (19%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C3 (N_S) HVAC

Run Date/Time: 12/29/09 @ 14:51

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	778.2	0.0	0.0	65.5	0.0	0.0	28.2	0.0	871.9
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	544.4	0.0	0.0	68.6	0.0	0.0	28.1	0.0	641.1

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	233.84 (30%)	--	--	-3.11 (-5%)	--	--	0.07 (0%)	--	230.81 (26%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	233.84 (30%)	--	--	-3.11 (-5%)	--	--	0.07 (0%)	--	230.81 (26%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 (N_S) HVAC   Run Date/Time: 12/29/09 @ 14:56

Annual Electric Energy by Enduse (pg 1 of 4)

Annual Energy USE (kWh)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	58,412	3,644	24,585	0	40,768	0	1,336	73,243	0	10,473	212,462
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	34,147	0	1,336	63,656	0	10,473	171,355

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	6.62 (16%)	--	0.00 (0%)	9.59 (13%)	--	0.00 (0%)	41.11 (19%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	6.62 (16%)	--	0.00 (0%)	9.59 (13%)	--	0.00 (0%)	41.11 (19%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 (N_S) HVAC Run Date/Time: 12/29/09 @ 14:56

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

Annual Energy Coincident Demand (kW)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	38.2	0.0	0.0	13.7	0.0	0.0	79.1
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	33.6	0.0	0.0	13.1	0.0	0.0	65.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.56 (12%)	--	--	0.63 (5%)	--	--	13.30 (17%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.56 (12%)	--	--	0.63 (5%)	--	--	13.30 (17%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C4 (N_S) HVAC | Run Date/Time: 12/29/09 @ 14:56

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	38.2	0.0	0.6	13.7	0.0	2.9	79.1
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	33.6	0.0	0.6	13.1	0.0	2.9	65.8

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.56 (12%)	--	0.00 (0%)	0.63 (5%)	--	0.00 (0%)	13.30 (17%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	4.56 (12%)	--	0.00 (0%)	0.63 (5%)	--	0.00 (0%)	13.30 (17%)

Annual Fuel Energy by Enduse (pg 4 of 4)

Annual Energy USE (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	0.0	596.1	0.0	0.0	67.9	0.0	0.0	27.0	0.0	691.0
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	431.8	0.0	0.0	70.3	0.0	0.0	27.0	0.0	529.1

Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

Incremental SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	164.27 (28%)	--	--	-2.39 (-4%)	--	--	0.04 (0%)	--	161.93 (23%)

Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

Cumulative SAVINGS (MBtu)	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	164.27 (28%)	--	--	-2.39 (-4%)	--	--	0.04 (0%)	--	161.93 (23%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 (N_S) HVAC Run Date/Time: 12/29/09 @ 15:03

Annual Electric Energy by Enduse (pg 1 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (kWh)											
0 Base Design	58,412	3,644	24,585	0	74,587	0	213	62,480	0	10,473	234,393
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	33,514	3,644	24,585	0	60,348	0	213	52,053	0	10,473	184,830

Incremental SAVINGS (MWh) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	14.24 (19%)	--	0.00 (0%)	10.43 (17%)	--	0.00 (0%)	49.56 (21%)

Cumulative SAVINGS (MWh) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	24.90 (43%)	0.00 (0%)	0.00 (0%)	--	14.24 (19%)	--	0.00 (0%)	10.43 (17%)	--	0.00 (0%)	49.56 (21%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 (N_S) HVAC | Run Date/Time: 12/29/09 @ 15:03

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

Annual Energy Coincident Demand (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	39.0	0.0	0.0	13.1	0.0	0.0	79.2
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	32.7	0.0	0.0	11.9	0.0	0.0	63.7

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

Incremental SAVINGS (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	6.24 (16%)	--	--	1.18 (9%)	--	--	15.52 (20%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

Cumulative SAVINGS (kW)	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	6.24 (16%)	--	--	1.18 (9%)	--	--	15.52 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 (N_S) HVAC Run Date/Time: 12/29/09 @ 15:03

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

Annual Energy Non-Coincident Demand (kW)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	19.0	1.4	6.7	0.0	39.0	0.0	0.6	13.1	0.0	2.9	79.2
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	10.9	1.4	6.7	0.0	32.7	0.0	0.6	11.9	0.0	2.9	63.7

Incremental SAVINGS (kW) **(values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	6.24 (16%)	--	0.00 (0%)	1.18 (9%)	--	0.00 (0%)	15.52 (20%)

Cumulative SAVINGS (kW) **(values (and % savings) are relative to the Base Case, negative entries indicate increased demand)**

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+DG Window	--	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	8.11 (43%)	0.00 (0%)	0.00 (0%)	--	6.24 (16%)	--	0.00 (0%)	1.18 (9%)	--	0.00 (0%)	15.52 (20%)

Project: 0909 - DoD 12-05-09 SM.30.2F.C5 (N_S) HVAC Run Date/Time: 12/29/09 @ 15:03

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	76.8	0.0	0.0	75.6	0.0	0.0	24.1	0.0	176.6
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	0.0	62.1	0.0	0.0	75.9	0.0	0.0	24.2	0.0	162.1
Incremental SAVINGS (MBtu) **(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)**										
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	14.73 (19%)	--	--	-0.22 (-0%)	--	--	-0.01 (-0%)	--	14.50 (8%)
Cumulative SAVINGS (MBtu) **(values (and % savings) are relative to the Base Case, negative entries indicate increased use)**										
1 0+DG Window	--	--	--	--	--	--	--	--	--	--
2 0+R-38 Roof Insulation	--	--	--	--	--	--	--	--	--	--
3 0+LPD	--	--	--	--	--	--	--	--	--	--
4 0+R-19 Wall Insulation	--	--	--	--	--	--	--	--	--	--
5 0+Combo of ECMs	--	14.73 (19%)	--	--	-0.22 (-0%)	--	--	-0.01 (-0%)	--	14.50 (8%)