

**INCREMENTAL COSTS OF MEETING ASHRAE STANDARD 189.1 AT AIR FORCE FACILITIES  
AN EVALUATION OF FOUR AF MILCON PROJECTS  
June 2011  
OFHPGB Notes 01.19.12**

Study Focus: What is the incremental additional cost to meet 189.1? (beyond Guiding Principles, federal requirements and LEED silver)

- First costs only
- Four facility types: Fitness center, hangar, dormitory, weather agency (office building)
- Four climate zones
- Only prescriptive path reviewed - performance path could allow less expensive options
- IgCC also included

Our analysis followed four steps. The first was to crosswalk the requirements of the ASHRAE Standard 189.1 with those of ASHRAE Standard 90.1 (2010 version), LEED requirements, the High Performance Sustainable Buildings (HPSB) Guiding Principles, DoD policy, UFC, and the International Green Construction Code (see Appendix A for the detailed crosswalk results)<sup>1</sup>. The idea was to isolate the ASHRAE Standard 189.1 requirements that are more strict than those of all of the other green building standards.

- DoD requires LEED Silver, with 40% of points in energy and water
- Navy requires LEED Gold (beginning FY 13)
- Army requires certain aspects of 189.1

Based on "detailed examination of facility specifications, design drawings, and LEED submission documents, and then comparing these to the ASHRAE Standard 189.1 requirements to determine whether a facility already met or exceeded them... cost estimates... focused particularly on requirements thought to impose substantial costs. Some judgment was required, because ASHRAE Standard 189.1 contains many detailed specifications that exceed the other green building standards but would impose relatively small additional costs... However, some requirements deemed to have little to no cost may have resulted in programmatic changes at the installation - these were not considered... Those requirements affecting how entire programs are executed (e.g., energy, metering) are discussed in the conclusions..."

"...final step was to sum the incremental costs for full compliance with all requirements that we ascertained to be of relatively major importance... All of the AF buildings studied herein attained at least LEED Silver certification, and in one case LEED Gold and in another LEED Platinum. With AF buildings starting from a higher level of sustainability, the incremental costs of achieving yet a higher standard may be less."

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<sup>1</sup> See Appendix A: Complete Crosswalk

This appendix summarizes and compares the high performance sustainable building requirements of ASHRAE 189.1, ASHRAE 90.1, applicable DoD directives, Unified Facilities Criteria, and the International Green Construction Code, and identifies instances where ASHRAE 189.1 is more stringent.

## CONCLUSION (Page 7-1)

Table 7-1. Summary of Incremental Costs of Meeting ASHRAE Standard 189.1 (p. 7-1)

Facility	Initial cost	Added cost to meet std	On site renewable cost	Certification/climate
Offutt (Office)	\$27m	7.1%	4%	LEED gold, climate zone 5A
Tyndall (Fitness center)	\$18m	1.3%	1%	LEED platinum, climate zone 2A
Travis (Maintenance hangar)	\$25.4M	2.8%	1.7%	LEED silver, climate zone 3B
Minot (Dormitory)	\$22.9M	2.3%	1.9%	LEED silver, climate zone 7A

### Summary conclusions:

First, because USAF buildings already meet at least LEED silver requirements (if not gold or platinum) plus other sustainable building standards, the added costs to meet ASHRAE Standard 189.1 are fairly modest, at least as a percentage of total building construction costs.

Why are the Offutt Weather Agency Headquarters facility incremental costs that much higher? There are two reasons. First, it is a very large building, with almost 189,000 sq ft of covered space. Since the requirements for renewable energy are tied to the amount of conditioned space and the renewable requirement is the largest cost component, the facility shows the largest incremental cost. Second, the Offutt facility is unusual in that it uses a large former runway for parking space, but this runway likely did not meet the ASHRAE Standard 189.1 for shading or reflectivity, so a costly concrete overlay on that area would have been necessary. Also, because of its orientation, the facility was unique among the four buildings in not meeting a fenestration requirement; however, we did not estimate what it would have cost to orient the building in a different direction.

In each case, our cost estimate for the supply of renewable energy assumed that a rooftop PV system would be used. It may be that other, cheaper means could have been available in some instances (e.g., wind energy, methane extraction from waste, geothermal), or that the exceptions allowed under ASHRAE Standard 189.1—which entail purchasing a minimum quantity of renewable energy and producing a minimum amount via solar collectors facing due south—would have been less costly. However, none of the four sites indicated that they were considering a solar collector, though two indicated that they were purchasing renewable energy from elsewhere.

In a few cases, other USAF considerations besides cost might have interfered with meeting the ASHRAE Standard 189.1. For example, the standard requires being able to reduce a building's energy usage by 10 percent at peak load times. However, if a building provides mission-critical functions, USAF might choose not to build such a usage reduction into its energy management systems. Also, under ASHRAE Standard 189.1, electricity, gas, and water meters must have remote reading capability, but AF has ordered a strategic pause in connecting new meters to existing remote meter reading systems due to security concerns and the pursuit of a standardized platform.

### **Offut Weather Agency HQ**

- Nebraska - colder than average climate, wind
- LEED gold
- Mid rise office (3 stories) 188,930 ft<sup>2</sup>
- 842 surface parking spaces on disused runway

Offut relates to 72 of the 189.1 requirements - meets or exceeds 64 with baseline AF requirements; 7 requirements adding major cost:

- Hardscape reflectivity
- Metering, submetering and remote data reading for potable and reclaimed water
- Consumption data recording and remote data collection for electricity, gas, district heat
- Onsite renewables mandate
- Fenestration and orientation requirements
- Exhaust air energy recovery systems
- Biobased products percentage of total

"...estimate of the total cost is about \$1.92 million, or roughly 7 percent of the \$27 million total cost of construction. Of this, by far the biggest element is the cost of renewable energy production, which alone would have added about 4 percent. The next biggest cost pertains to the reflectivity of the parking area, which would have added \$544,000, or about 2 percent.

Strategy to meet 189.1 requirements/incremental cost summary (major)

- Hardscape: re-use of old runway for parking lot does not meet SRI -replace parking, most cost effective \$544,000
- Water consumption data - add 5 remote meters on cooling towers and boilers - \$116,175
- Energy Submetering - building has extensive BAS, would have to add gas meter \$9,000 - remote data collection not allowed in current F security policy
- On site renewables - PV (see PNNL study of alternatives) with Energy Star equipment \$1,077,300  
W/o energy star equipment \$1,616,000
- Building orientation could address fenestration - no cost calculated, would not meet requirements
- Exhaust air energy recovery \$55,000

- Biobased materials - additional labor associated with wood instead of concrete \$60,000 rough estimate.

Requirements that add minimal costs - See summary 3.15 - 3.17 (no \$\$)

### **Tyndall Fitness Center**

Florida warm climate

Built to LEED platinum

72,666 ft<sup>2</sup>

Requirements adding major cost/policy issues preventing attainment of 189.1

- Hardscape shading \$45,000
- On site renewables PV \$417,636
- Top lighting \$7,000
- AF policy re: remote data collection = Tyndall would not meet ASHRAE 189.1

"REQUIREMENTS THAT ADD MINIMAL COST" table 4.7 -4.8 (no \$\$)

### **Travis C-17 Hangar**

California - SF area

2 bay hangar Maintenance shop and office space

One story 102,000 ft<sup>2</sup>, 83,028 conditioned space

LEED silver certified

- Green power purchase = NZE
- Certified wood
- Reflective paving

Requirements adding major cost/policy issues preventing attainment of 189.1

- Energy consumption gas meters \$6,000
- On site renewables \$429,000
- Exhaust air energy recovery \$27,000
- Top lighting \$122,000
- Biobased (wood) \$91,000
- Peak energy demand reduction conflicts with mission and AF policy

Content: "REQUIREMENTS THAT ADD MINIMAL COST" table 5.5 -5.6 - \$40,000

### **Minot Dormitory**

Mid rise residential (3 stories)

North Dakota - Cold climate - heat load dominant

LEED silver design

- Energy savings 47% over 90.1 (1994)
- Ground source heat pumps with heat exchangers

Requirements adding major cost/policy issues preventing attainment of 189.1

- Green field site - would not meet ASHRAE 189.1, assume \$49,670 to add landscaping
- Renewables - rooftop PV \$426,000
- Energy recovery ventilators \$24,000

Except for on site renewables, Minot could meet 189.1 at low incremental cost

REQUIREMENTS THAT ADD MINIMAL COSTS" Table 6.5 - \$30,000 total

#### NREL July 2010 review of ASHRAE 189.1 (P. 2-3 to 4)<sup>2</sup>

- ASHRAE 189.1 designed to yield 30% more energy efficiency than 90.1 2007. Standard 189.1-2009 goes much further in terms of energy savings over Standard 90.1-2007 than Standard 90.1-2007 does over its 2004 counterpart. This analysis shows that the weighted average savings seen in the former comparison are roughly 8 times those seen in the latter."
- Results vary significantly by building type.
- Buildings in very cold climate zones (6A, 7, 8) show significantly higher savings than those in climate zones 1-5.
- Two-thirds of the savings of Standard 189.1-2009 over Standard 90.1-2007 come from energy efficiency measures, and about one-third from the renewable energy requirement in Standard 189.1-2009.
- Low-EUI sectors, such as offices and warehouses, show large energy savings because the 4.0 kBtu/ft<sup>2</sup> (45 MJ/m<sup>2</sup>) renewable energy savings constitute a larger percentage of the total building EUI than for high-EUI sectors.
- Lodging buildings dominated by guest room space, as in the small hotel model, show significant additional savings. These savings come from the Standard 189.1-2009 requirements to setback lighting, plug loads, and HVAC when rooms are unoccupied.
- Healthcare buildings see smaller savings because medical plug loads constitute such a large portion of their energy consumption, yet standard methods for reducing their intensity (ENERGY STAR) have not been written.
- Generally, as Standard 189.1-2009 pushes the boundaries of efficiency for lighting and HVAC equipment, as well as some plug loads, the "other" process loads become more critical to a building's potential for energy savings. Future research needs to address these loads.

"HPSB Guiding Principles and ASHRAE Standard 189.1 took their shape from the LEED rating system which explains why there are so many similarities and overlaps exist." (p. 2-3)

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<sup>2</sup> Evaluation of ANSI/ASHRAE/USGBC/IES Standard 189.1-2009, Nicholas Long, Eric Bonnema, Kristin Field, and Paul Torcellini (July 2010)