US Army Corps of Engineers®

Efficient Technologies to Reduce Building Energy Use and Meet Federal Requirements

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Energy Conservation Technologies to Meet EPAct 2005 Requirements in Newly Constructed Army Buildings

- The 2005 Energy Policy Act requires that Federal facilities be built to achieve at least a 30 percent energy savings over the 2004 International Energy Code or ASHRAE Standard 90.1-2004 as appropriate, and that energy efficient designs must be life cycle cost effective.
- A team comprised of researchers and engineers of Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL), Department of Energy National Renewable Energy Laboratory, USACE Centers of Standardization and the Military Technology Group of the American Society of Heating Refrigeration and Air-Conditioning Engineers has developed design guides to achieve 30 percent energy savings over a baseline built to the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1-2004 for new buildings to be constructed under Military Transformation Program.

Saving Energy without Jeopardizing Building Function and Sustainability, Comfort and Productivity

- The simplest, most cost-effective, and easiest way to save energy in a building is to turn off all the lights, all the heating and cooling systems, and unplug all the appliances and equipment. This building would use no energy whatsoever, but it would be uncomfortably cold and hot, inadequately ventilated, dimly lit by whatever light comes through the windows, and a very unpleasant place to work. Freezing in the dark is not the objective of energy conservation.
- The approach taken by the team was to meet Army's energy goals AND improve indoor air quality in buildings, prevent mold problems, increase soldier's wellbeing and productivity

Army Streamlined Approach

- Clear energy goals and requirements interpretations to contractor
- Whole building energy and IAQ optimization
- Reduced design costs
- Verifiable design objectives
- Reduced QC costs
- Economy of scale in purchasing process
- **BETTER ARMY BUILDINGS**

Buildings Included in the Study

- Permanent Party Barracks – similar to student dormitories and multi family apartment houses
- Training Barracks
- Administrative Buildings
- Vehicle Maintenance Facilities (TEMF)
- Dining Facilities (DiFac)
- Child Development Centers (CDC)
- Company Operation Facilities (COF) and
- Army Reserve Centers

How to Achieve 30% Energy Savings

- Between 2005 and 2007 ASHRAE has developed and published 4 Advanced Energy Design Guides (AEDGs): Small Office Buildings, Small Retail Buildings, Schools and Warehouses
- This presentation focuses on Permanent Party Barracks and Maintenance Facilities

Current ASHRAE AEDGs

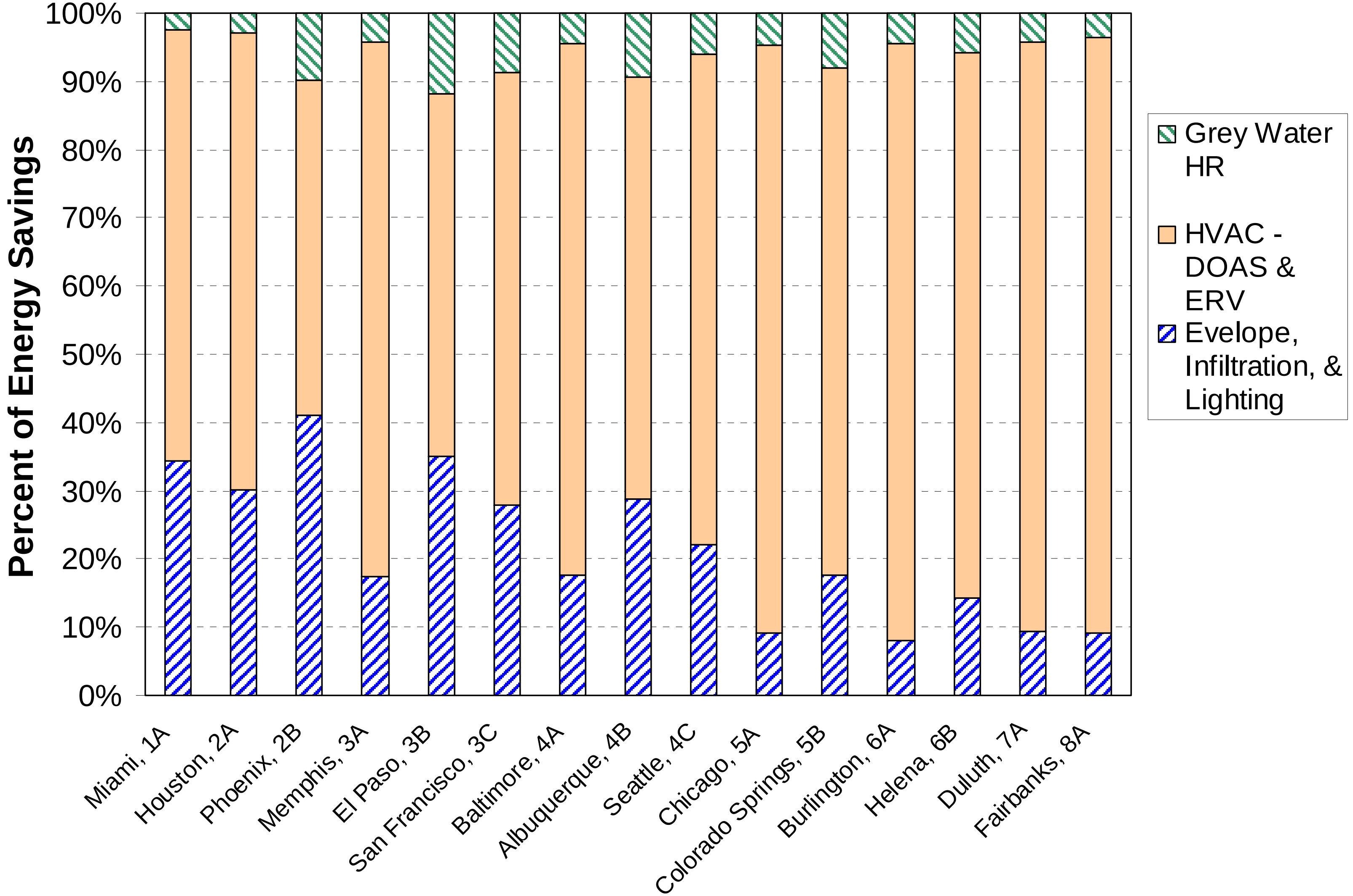
www.ashrae.org/aedg

Army Permanent Party Barracks

Major Areas of Improvement in Barracks

- Building envelope heat losses and gains
- Building air leakage resulting in additional heating and cooling sensible load and a significant latent load, and potential for mold/mildew problems
- Heating and cooling efficiency improvement
- Water heating for showers
- Lighting efficiency

Percent of Total Energy Savings by ECM for Permanent Party Barracks



Examples of Older Poorly Insulated Barracks

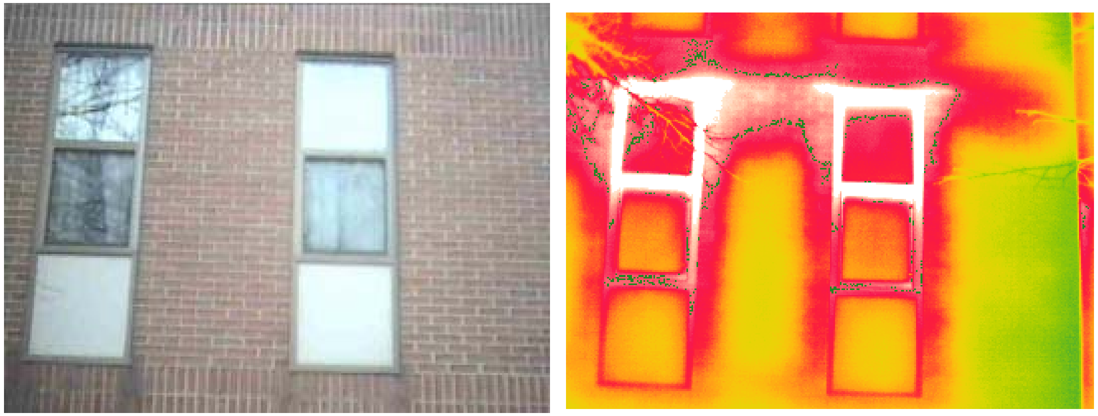
Building Envelope

- Building envelope insulation levels were adopted from the ASHRAE AEDG for Small Office Buildings
- Requirement to use reflective metal roofing materials ("cool" roof) – FEMP designated ENERGY STAR® roofing products.
- Requirement to use advanced windows
- Requirements to use much tighter buildings, continuous air barrier and a "blower door" test

Infiltration Rates

Source	Leakage Rate at 75 Pa (cfm/ft^2)	Leakage Rate at 5 Pa (cfm/ft^2)	Air Changes per Hour at 5 Pa
Average value from CERL testing	0.55	0.095	0.60
ASHRAE 90.1-2004 proposed addendum	0.40	0.069	0.44
Army standard for new construction	0.25	0.043	0.27
Best practice	0.15	0.026	0.16

Examples of Areas with Airtightness Problems

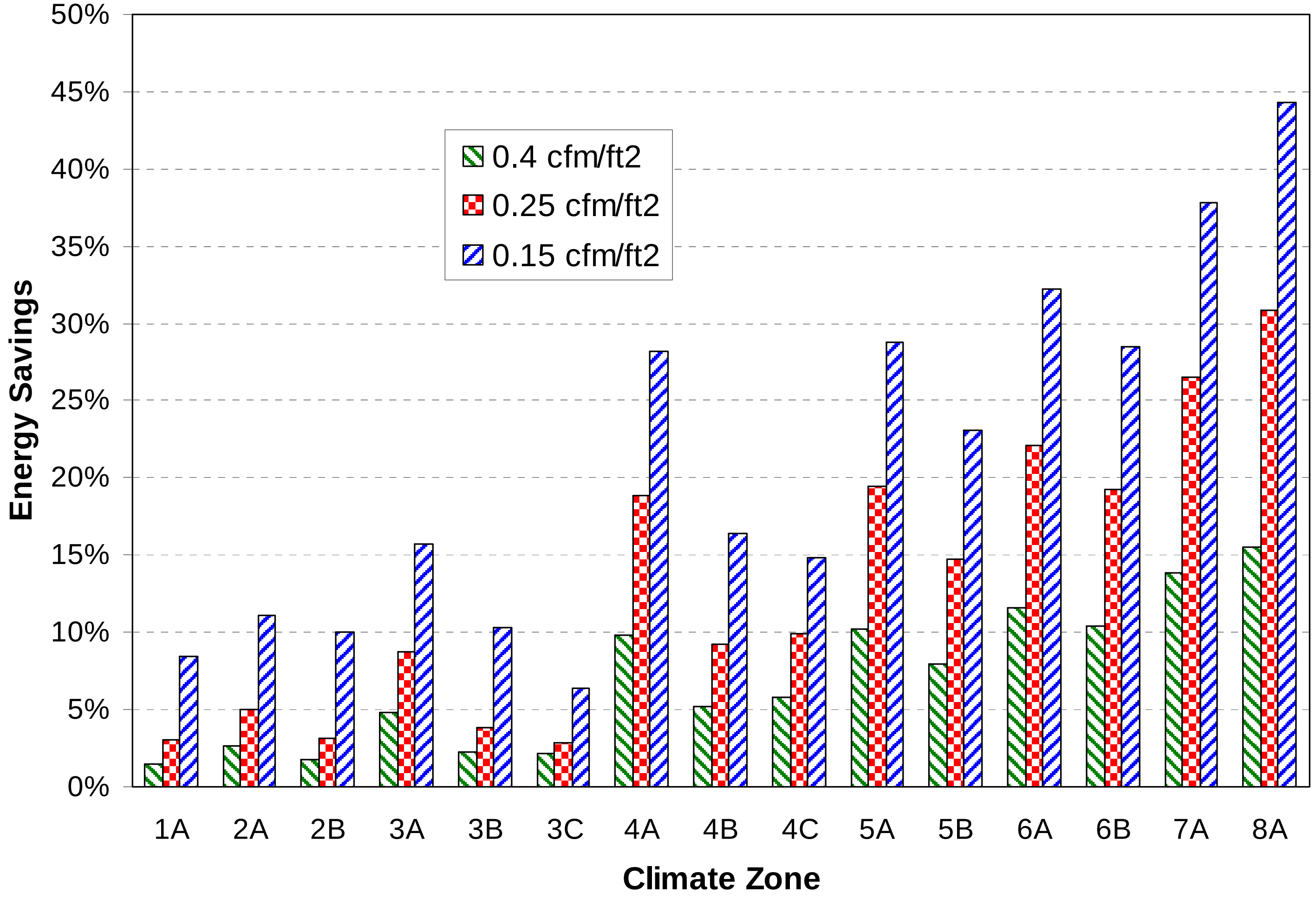


Blower-door tests complemented by thermography identifies problems with building air tightness and areas with poor insulation where leakage occurs (red and white areas in photos to the right).

Unsealed chases between floors and the attic

Soldiers' Rooms are open Directly to the Outside
Result – huge latent load on AC, which can't be satisfied

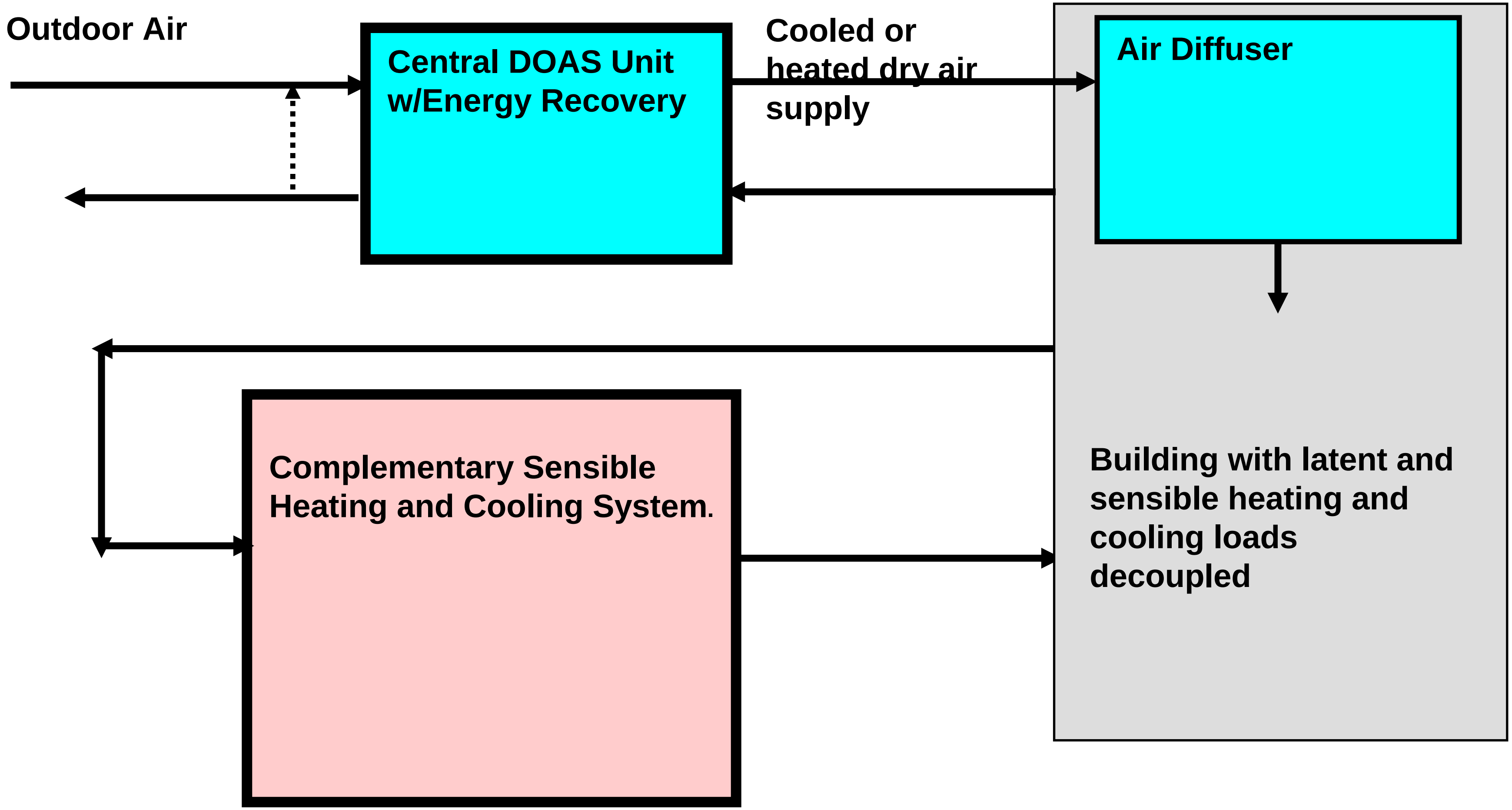
Annual Energy Savings in Barracks due to Increased Airtightness



Dedicated Outdoor Air System and its Application to Humid Climates

- Dedicated Outdoor Air System (DOAS) delivers 100% OA to each individual space in the building via its own duct system. Airflow rates generally are dictated by
  - Indoor air quality needs (based on ASHRAE Std. 62.1-2004 or better);
  - Make-up air for bathroom and kitchen exhausts (when needed);
  - Latent load (dehumidified supply air provides humidity control);
  - Building pressurization to prevent infiltration which allows for reduction of heating/cooling and moisture loads.

DOAS Concept



Types of Complementing Heating and Cooling System for Barracks

- Radiant ceiling system (suspended or embedded into the ceiling)
- Fan coil units, FCU (four pipe or DX fan-coil units)
- Water source heat pumps
- Other packaged terminal equipment

Radiant Heating and Cooling System Vs. Fan Coil Units

- FCU supplies air with a low temperature and creates a higher risk of condensation and mold
- FCU has mechanical parts which require more maintenance
- FCU requires lower chilled water T (45-50ºF Vs. 60ºF for radiant system) which creates a potential problem with condensation on piping/connection
- FCU supplies air with a lower temperature (55ºF) which creates a potential problem with condensation and mold on air diffuser and adjacent surfaces

Radiant Heating/Cooling System

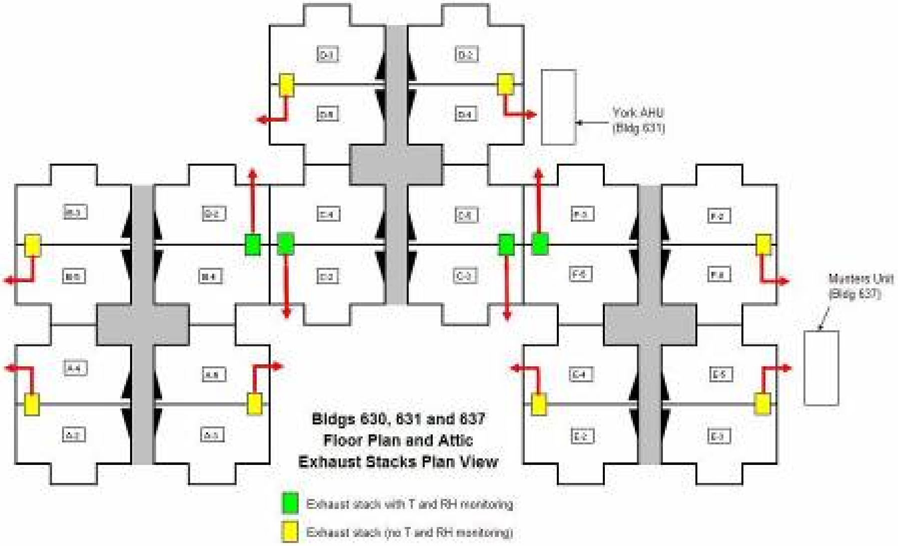
Installation of the capillary radiant heating/cooling system on the pre-finished surface

Two-side cooling mat detail with water feeding (or water return)

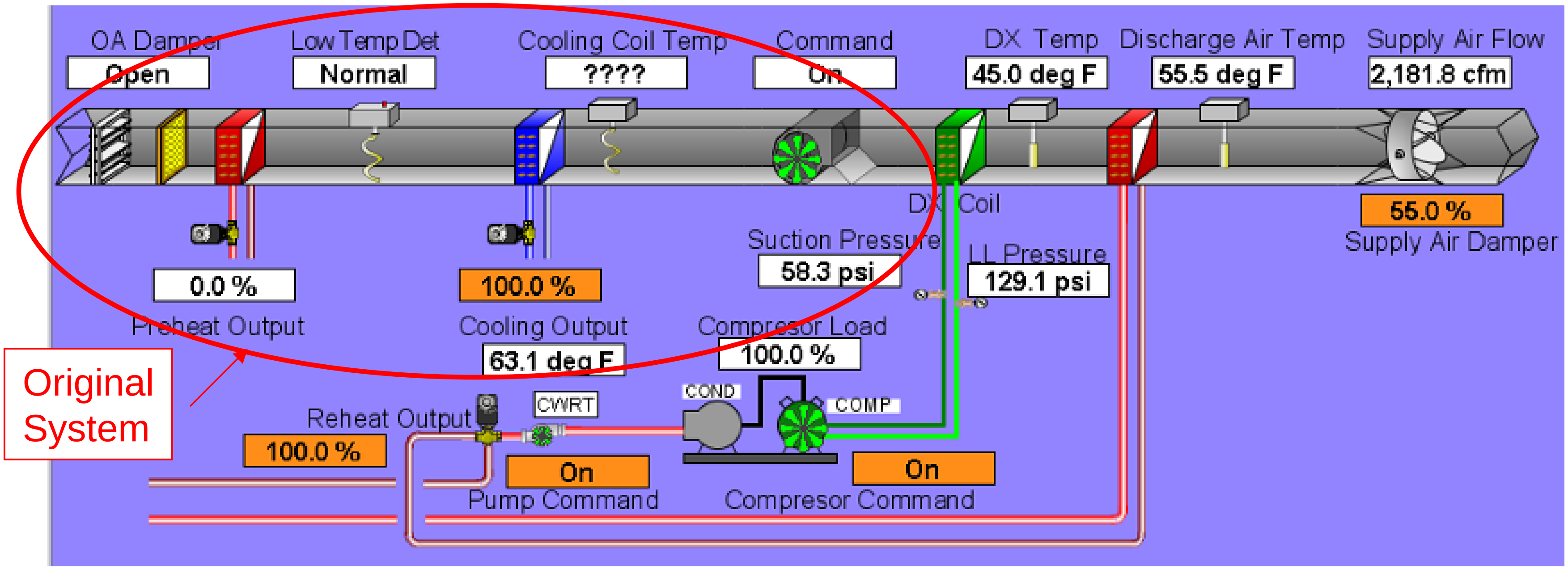
Radiant Heating/Cooling System

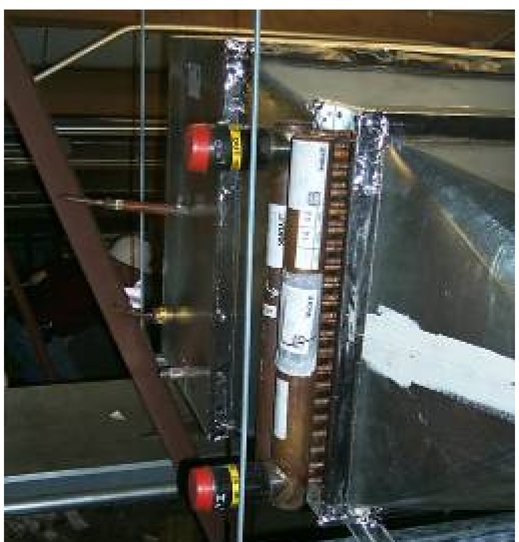
- The chilled ceiling can provide capacity up to 25 Btu/sq.ft. This capacity is generally sufficient if the building is sufficiently insulated and has a DOAS
- Pipes and fittings are made out of polypropylene (plastic). Cooling and heating by Capillary Tubes is not new to the HVAC industry. It was used for commercial and institutional projects over in Europe for the last fifteen years. Has at least 2 suppliers BEKA, USA and KaRo. See www.beka-klima.de for list of completed projects.
- The capillary tubes (material only) for drywall/plaster or concrete is around $6.00/sq.ft. Additional $8.00/sq.ft. will be for installation.

Ft. Stewart DOAS Systems



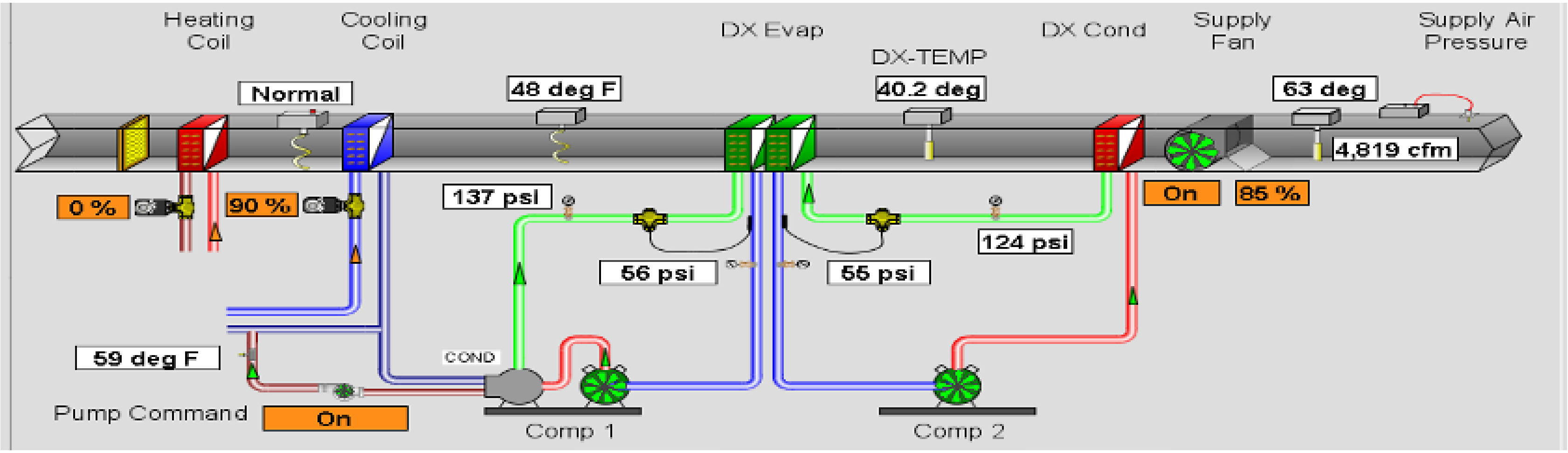
DOAS: chilled water system augmented with DX





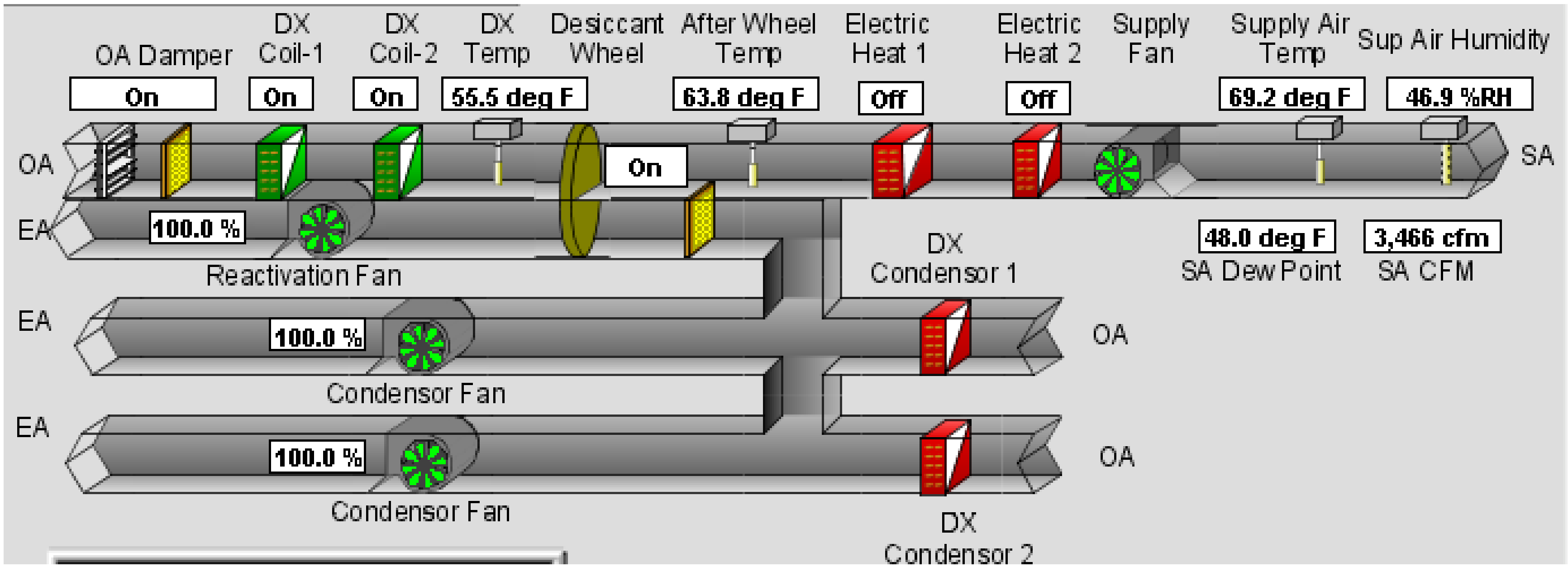
- Three existing attic outdoor air systems augmented with DX dehumidification systems and condenser reheat.
- OA air quantities increased 25% over original system

DOAS: DX Dehumidification/Reheat System Added to a Standard Commercial AHU



- Three existing attic outdoor air systems abandoned
- DX dehumidification/reheat system added to a standard commercial AHU, connected to existing ductwork
- OA air quantities increased 25% over original system

DOAS with a Desiccant Dehumidification/Reheat



Three existing attic outdoor air systems abandoned

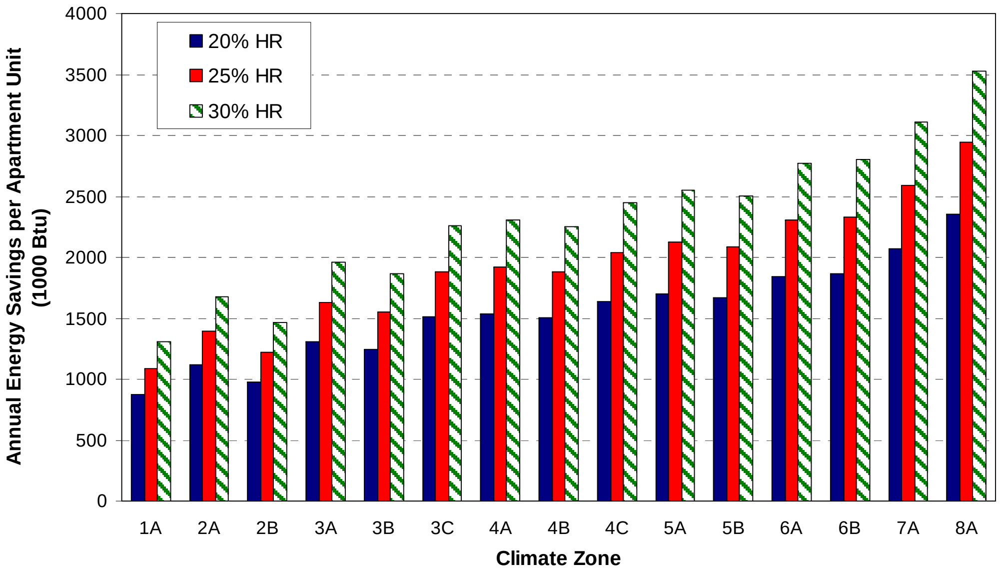
- All-electric desiccant dehumidification / reheat system installed and connected to existing ductwork
- OA air quantities increased 25% over original system

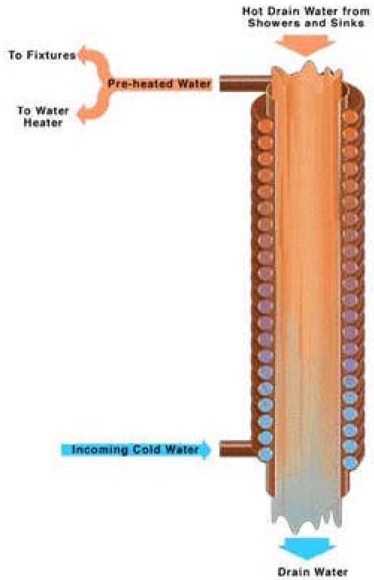
Supply/Exhaust Laundry Room Ventilation Systems Decoupling

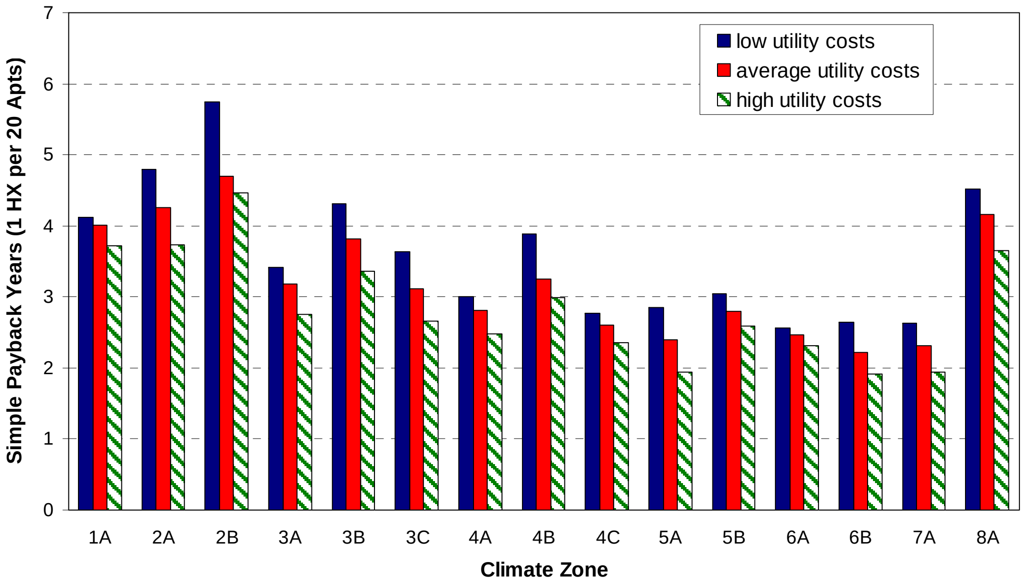
To reduce unneeded energy use for heating and cooling of the make-up air and for air transportation of supply and exhausted air from the dryers, laundry exhaust and supply systems are separated in the efficient building model from the rest of the building exhaust and supply systems. Laundry exhaust system and corresponding make-up systems operate only when dryers are operating.

- Baseline: washer/dryer use 24/7- 100%
- Government furnished solution: decoupled laundry room supply/exhaust ventilation system to match washer and dryer use: e.g., from 700 to 1000, from 1900 to 2100 and from 2300 to 2400 – 50%; from 21 to 2300 – 100%

Grey Water Heat Recovery from Showers







GFX system schematics and installation example

Pipe and Duct Insulation

Energy Efficient Technologies for Tactical Equipment Maintenance Facilities (TEMF)

Energy Efficient Design Solutions without Plug-in Loads

Climate Zone	City	Baseline kBtu/ft² (MJ/m²)	Final Energy Efficient Solution kBtu/ft² (MJ/m²)	Energy Savings
1A	Miami, FL	36 (125)	15 (52)	59%
2A	Houston, TX	45 (156)	19 (66)	58%
2B	Phoenix, AZ	42 (145)	17 (59)	59%
3A	Memphis, TN	56 (194)	25 (87)	56%
3B	El Paso, TX	47 (163)	20 (69)	58%
3C	San Francisco, CA	43 (149)	17 (59)	59%
4A	Baltimore, MD	75 (260)	35 (121)	53%
4B	Albuquerque, NM	61 (211)	27 (93)	56%
4C	Seattle, WA	64 (222)	29 (100)	54%
5A	Chicago, IL	93 (322)	45 (156)	52%
5B	Colorado Springs, CO	80 (277)	36 (125)	55%
6A	Burlington, VT	108 (374)	54 (187)	50%
6B	Helena, MT	99 (343)	49 (170)	50%
7A	Duluth, MN	134 (464)	65 (225)	51%
8A	Fairbanks, AK	207 (716)	105 (363)	49%

Recommended Energy Conservation Measures for TEMF by Climate Zones

Zone	City	Improved Envelope	Lighting & Daylighting	High Eff HVAC	Rad Floor Heating	Transpired Solar Collector	Energy Recovery
1A	Miami, FL						
2A	Houston, TX						
2B	Phoenix, AZ						
3A	Memphis, TN						VC & CB
3B	El Paso, TX						VC & CB
3C	San Francisco, CA						VC & CB
4A	Baltimore, MD						VC & CB
4B	Albuquerque, NM						VC & CB
4C	Seattle, WA						VC & CB
5A	Chicago, IL						VC & CB
5B	Col Springs, CO						VC & CB
6A	Burlington, VT						VC & CB
6B	Helena, MT						VC & CB
7A	Duluth, MN						RP, VC, CB
8A	Fairbanks, AK						RP, VC, CB

Include

Include but low savings

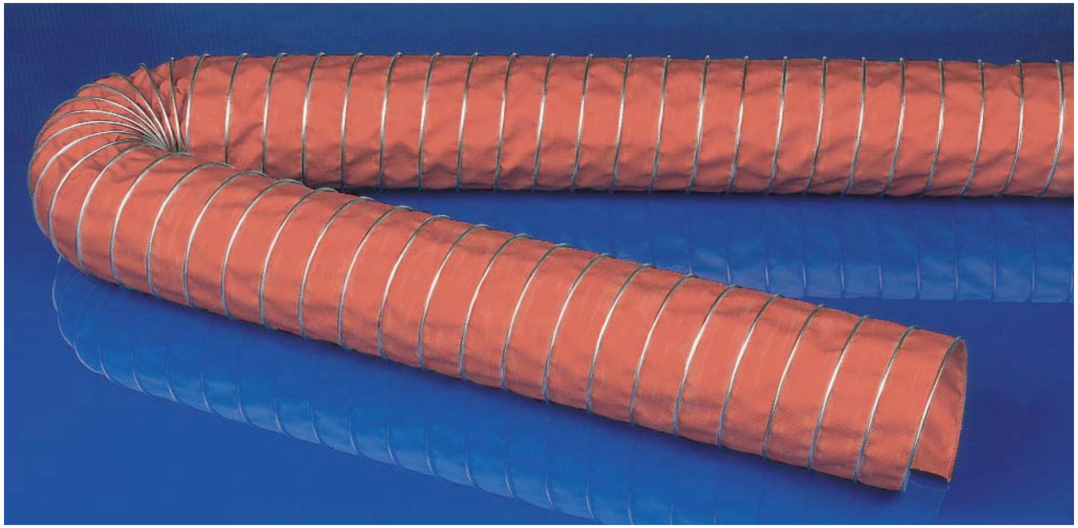
Not Included

VC= Vehicle Corridor
CB = Consolidated Bench
RB = Repair Bay


95
96

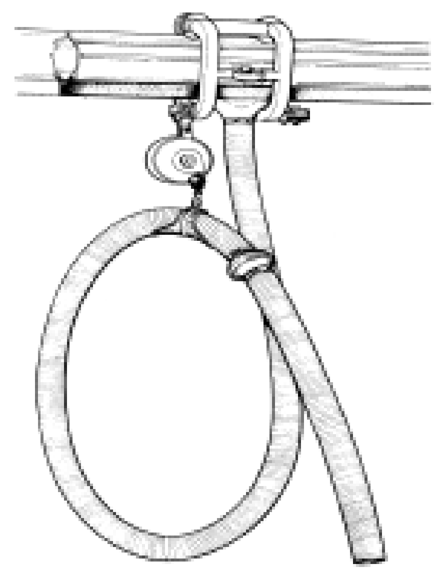
Temperature Resistant Hoses

EXHAUST GAS TEMPERATURES UP TO +570°F



EXHAUST GAS TEMPERATURES UP TO +1200°F

Mobile Vehicle Exhaust Examples



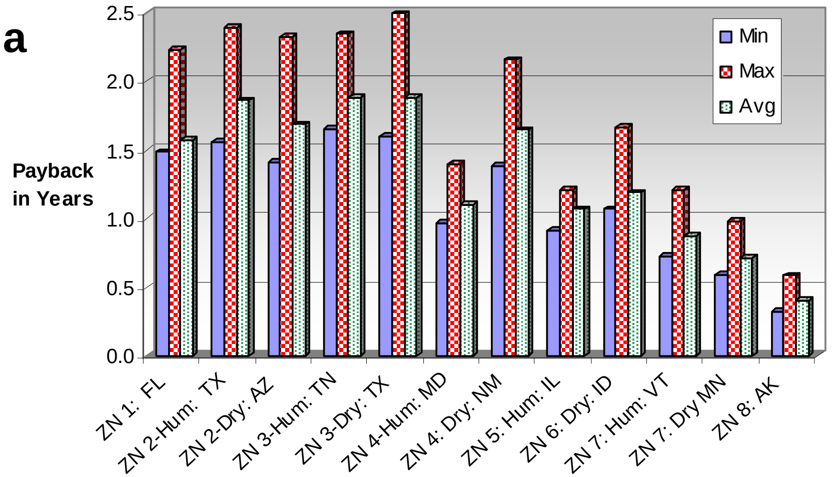
Example of a 10” (250mm), 2500cfm, T_{exh} < 1200°F Boom-based Vehicle Exhaust with a Temperature Resistant Hose

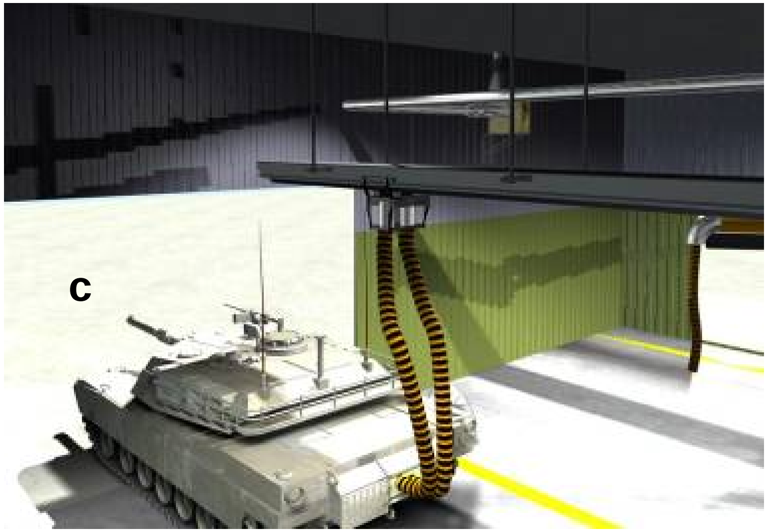





Close Capture Exhaust System for Moving and Stationary Vehicles

a





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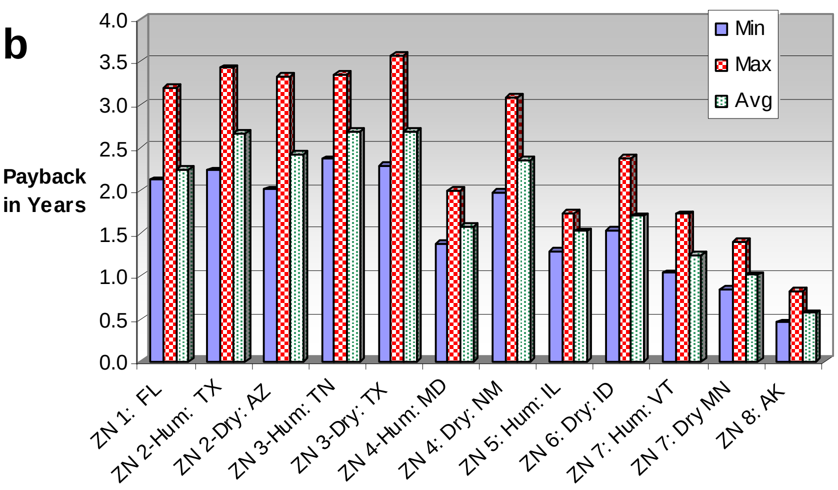
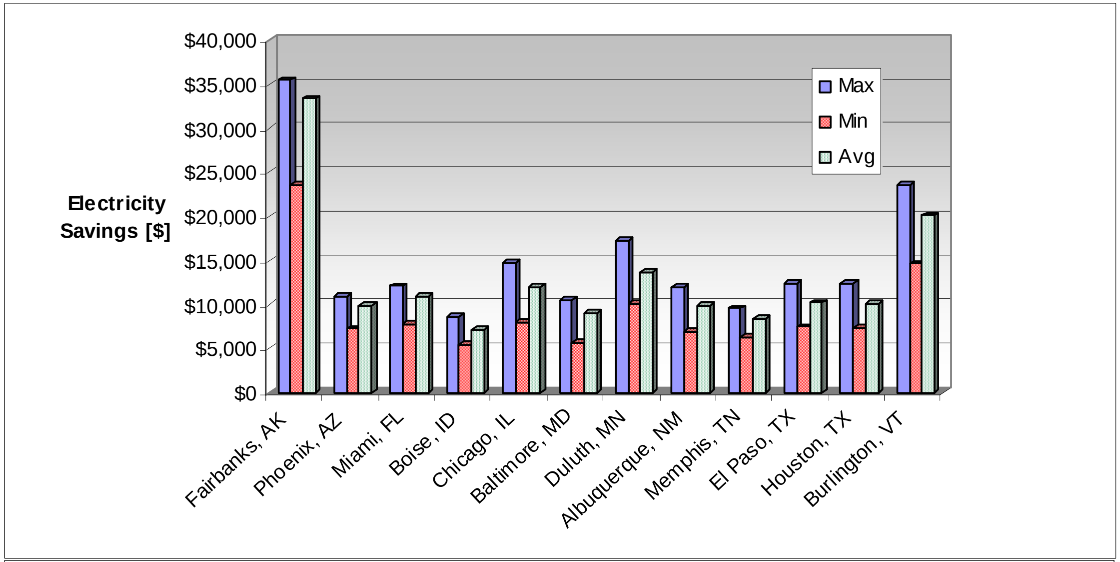
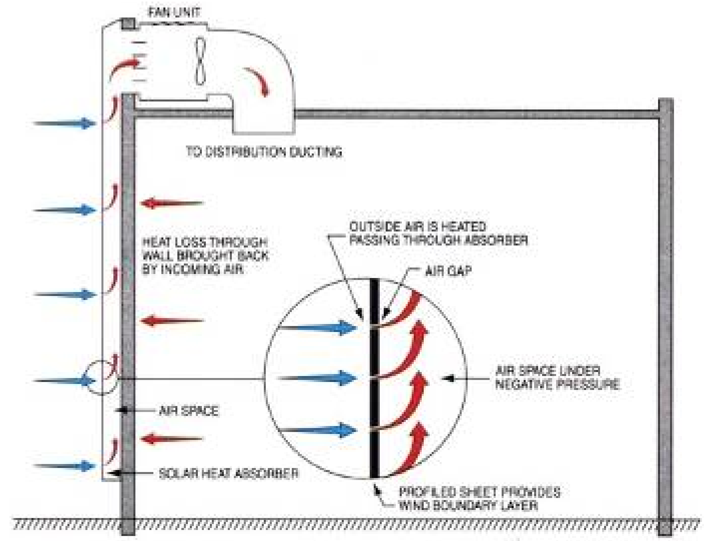
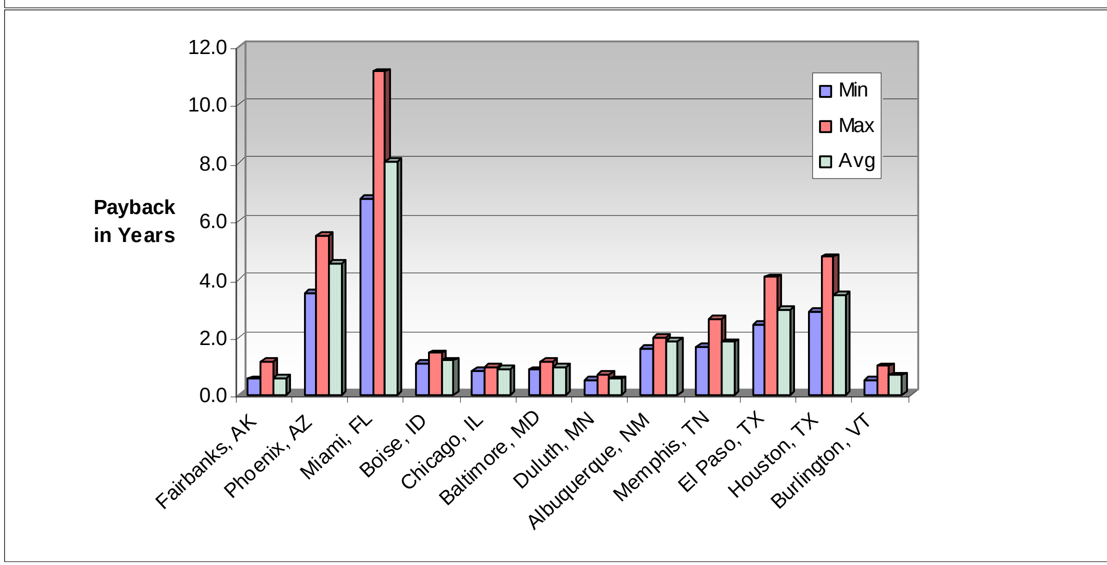


Estimated payback for a rail (a) and boom (b) system shown for high, medium, and low energy rates; (c) schematic of the rail system, (c) commercial application with boom-based system

Transpired Solar Wall







Electricity savings, estimated payback shown for high, medium and low energy rates, schematic, typical commercial application

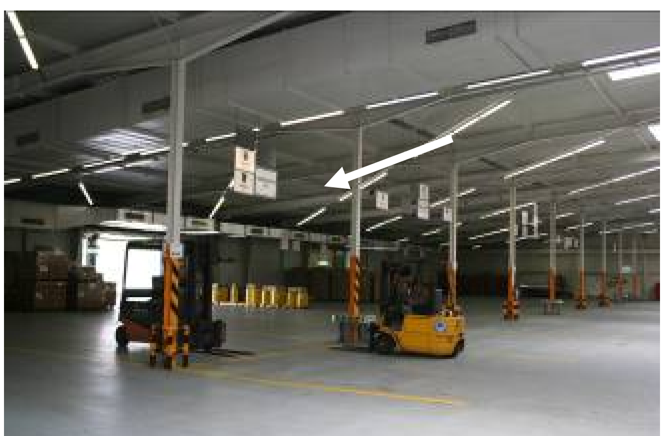
Examples of Supply Air Preheating using a “Solar Wall”

Ft. Drum maintenance facility retrofitted with solar wall (FY06)

Ft. Lewis DOL facility retrofitted with solar wall (FY05)

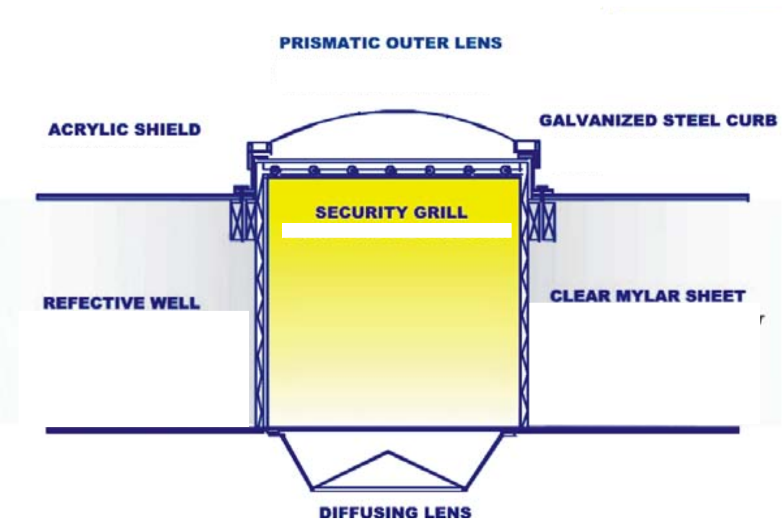
Examples of Low Efficiency Warm Air Heating Systems in Motorpools, Hangars and Warehouses

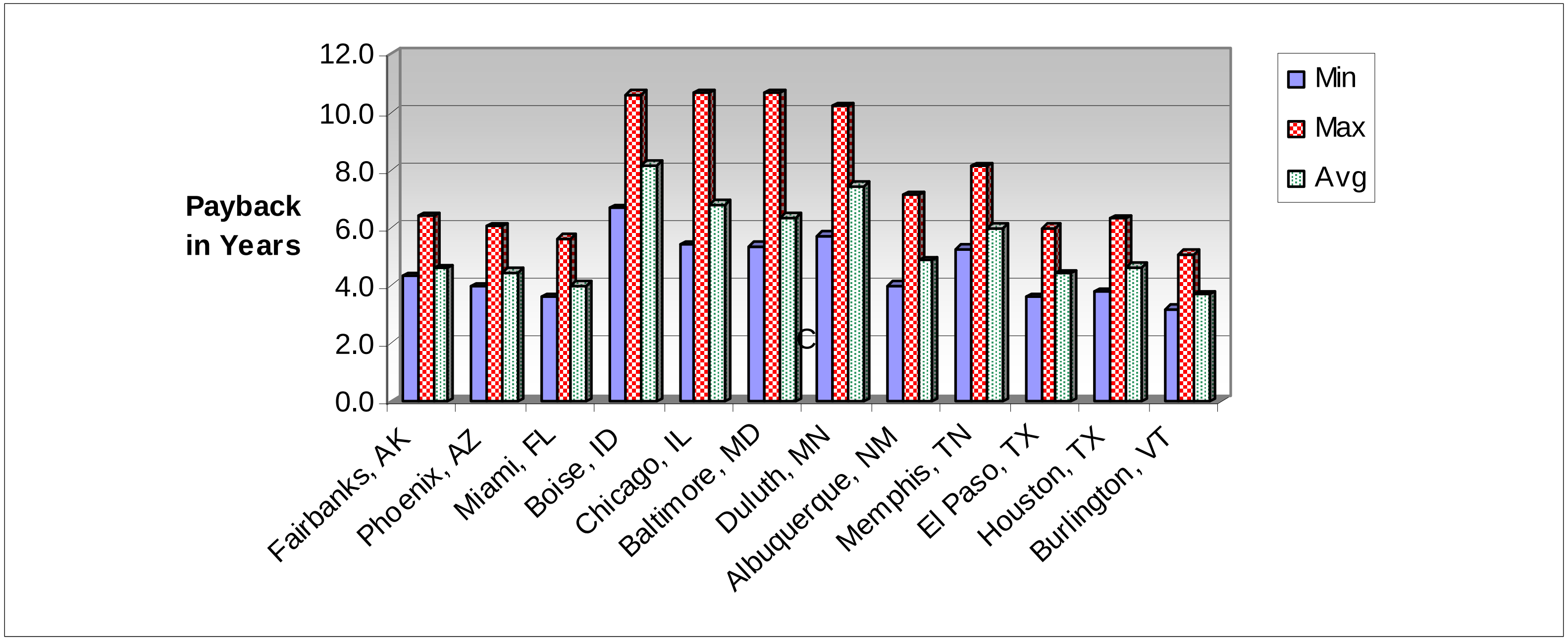


Radiant Floor Heating at Army TEMFs and Hangars

Hybrid Lighting





Questions or Comments ?

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Army New Facility Construction: Energy Conservation and EPACT 2005

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Energy Policy Act of 2005

"The Secretary shall establish, by rule, revised Federal building energy efficiency performance standards that require that—if life-cycle cost-effective for new Federal buildings—the buildings be designed to achieve energy consumption levels that are at least 30 percent below the levels established in the version of the ASHRAE Standard or the International Energy Conservation Code, as appropriate, that is in effect as of the date of enactment of this paragraph"

EPACT 2005 Applicable Codes

- 2004 International Energy Conservation Code
  - Applies to low-rise residential buildings
- ASHRAE 90.1-2004
  - Applies to all commercial buildings and high-rise residential buildings (this includes all Army buildings except family housing)

DOE "Rule" for "30% Better"

- All new Fed facilities 30% better energy consumption (cost) than ASHRAE 90.1-2004 or IECC 2004 facility
- Requires LCC analysis to show 30 percent or better savings is cost-effective
- Does not prohibit and does not require greater than 30 percent savings even if achievable and life cycle cost effective
- If 30% not achievable, must try for less energy savings in LCC effective manner but must comply with applicable standard as a minimum

Army Streamlined Approach To "30% Better"

- Clear energy goals and requirements to contractor for our repetitive facilities
- Whole building energy and IAQ optimization
- Reduced design costs
- Verifiable design objectives
- Reduced QC costs
- Economy of scale in purchasing process
- **BETTER ARMY BUILDINGS**

Army EPACT Study

- Goals:
  - To ensure effective/easy compliance with EPACT2005 in all Army MILCON projects
  - To develop specific Army Design/Build Request for Proposal guidance to simplify EPACT 2005 compliance during design/construction of repetitive Army facilities worldwide

Army EPACT Study

- The approach taken by the study team was to meet EPACT 2005 and other energy goals AND improve indoor air quality in buildings, prevent mold problems, increase soldier's well-being and productivity

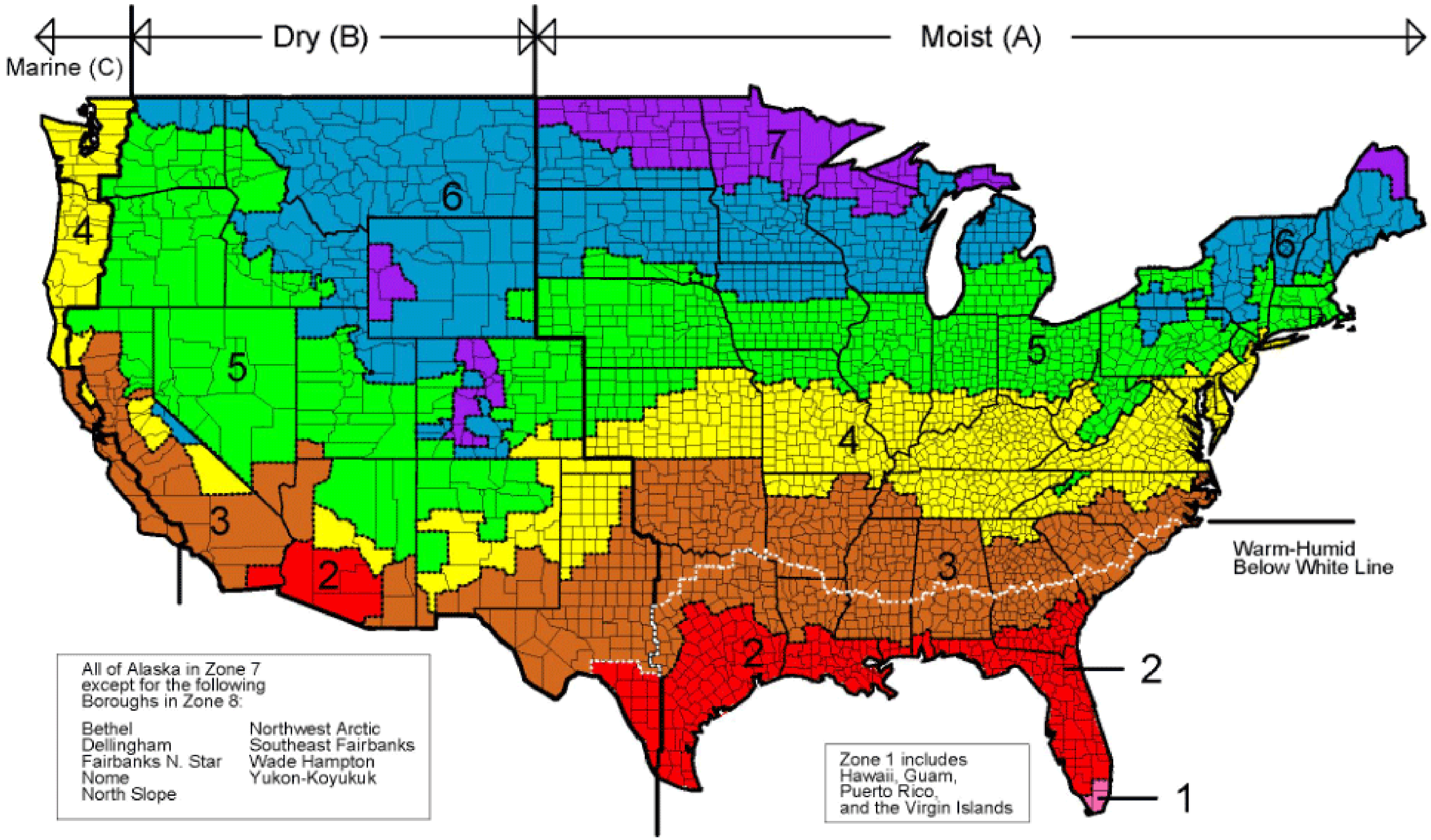
- Study performed by partnership including multiple Army Corps of Engineers offices, DOE's National Renewable Energy Laboratory, and ASHRAE

Army EPACT Study

- Developing “Design Energy Targets” for 30% Better Army Facilities
- Developing “Design Guides” describing one cost-effective path which achieves at least 30% savings

- Baseline is ASHRAE Standard 90.1-2004 for all facilities
- Based on energy consumption NOT energy cost
- Fifteen standard DOE climate zones
- Eight standard Army facility types

DOE U.S. Climate Zones



Selected Study Locations

Climate Zone	City	HDD (Base65ºF)	CDD (base 50ºF)
1A	Miami, FL	200	9474
2A	Houston, TX	1599	6876
2B	Phoenix, AZ	1350	8425
3A	Memphis, TN	3082	5467
3B	El Paso, TX	2708	5488
3C	San Francisco, CA	3016	2883
4A	Baltimore, MD	4707	3709
4B	Albuquerque, NM	4425	3908
4C	Seattle, WA	4908	1823
5A	Chicago, IL	6536	2941
5B	Colorado Springs, CO	6415	2312
6A	Burlington, VT	7771	2228
6B	Helena, MT	7699	1841
7A	Duluth, MN	9818	1536
8A	Fairbanks, AK	13940	1040

Building Types Included in the Study

- Permanent Party Barracks (like dormitories)
- Training Barracks
- Administrative Buildings
- Vehicle Maintenance Facilities (TEMF)
- Dining Facilities (DiFac)
- Child Development Centers (CDC)
- Company Operation Facilities (COF)
- Army Reserve Centers

Expected Study Results For Each Facility Type

- Table of Design Energy Targets that specify the energy consumption (in BTU/Ft^2-yr) to achieve 30% reduction compared to a 90.1-2004 design for each facility type and location

- A design guide showing one prescriptive path for achieving at least a 30% energy savings in an LCC effective manner for each facility type and location

- Language to implement above in Army standard Request for Proposals for Design-Build Projects

Original EPACT "30% Better" Compliance Path In DOE Rule

Perform energy and LCC analysis for both a baseline (just meets minimums of ASHRAE 90.1-2004) facility and the specific custom designed facility and show that the required 30% energy reduction is achieved in LCC effective manner

Two New Compliance Paths for A Specific MILCON Project

- Perform energy and LCC analysis for specific custom design and show that the specified design energy target is achieved in LCC effective manner

Or

- Follow “prescriptive design guide” for the building type/location and no further analyses required

Three Army Compliance Paths

<table>
<tr><th>Path 1</th><th>Path 2</th><th>Path 3</th></tr>
<tr><td>ASHRAE Standard 90.1-2004 Mandatory Requirements</td><td>ASHRAE Standard 90.1-2004 Mandatory Requirements</td><td>ASHRAE Standard 90.1-2004 Mandatory Requirements</td></tr>
<tr><td>ASHRAE Standard 90.1-2004 Prescriptive Requirements</td><td rowspan="2">US Army Performance Targets</td><td rowspan="3">US Army Prescriptive Design Guide Requirements

No calcs required</td></tr>
<tr><td>Achieve 30% Better Performance</td></tr>
<tr><td>ASHRAE Standard 90.1-2004 Appendix G calcs For baseline and Custom facility</td><td>ASHRAE Standard 90.1-2004 Appendix G calcs For Custom facility only</td></tr>
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EPACT Impact on Army New Construction Energy Requirements

Army Standard Request For Proposals for a Design-Build New Construction project now includes:

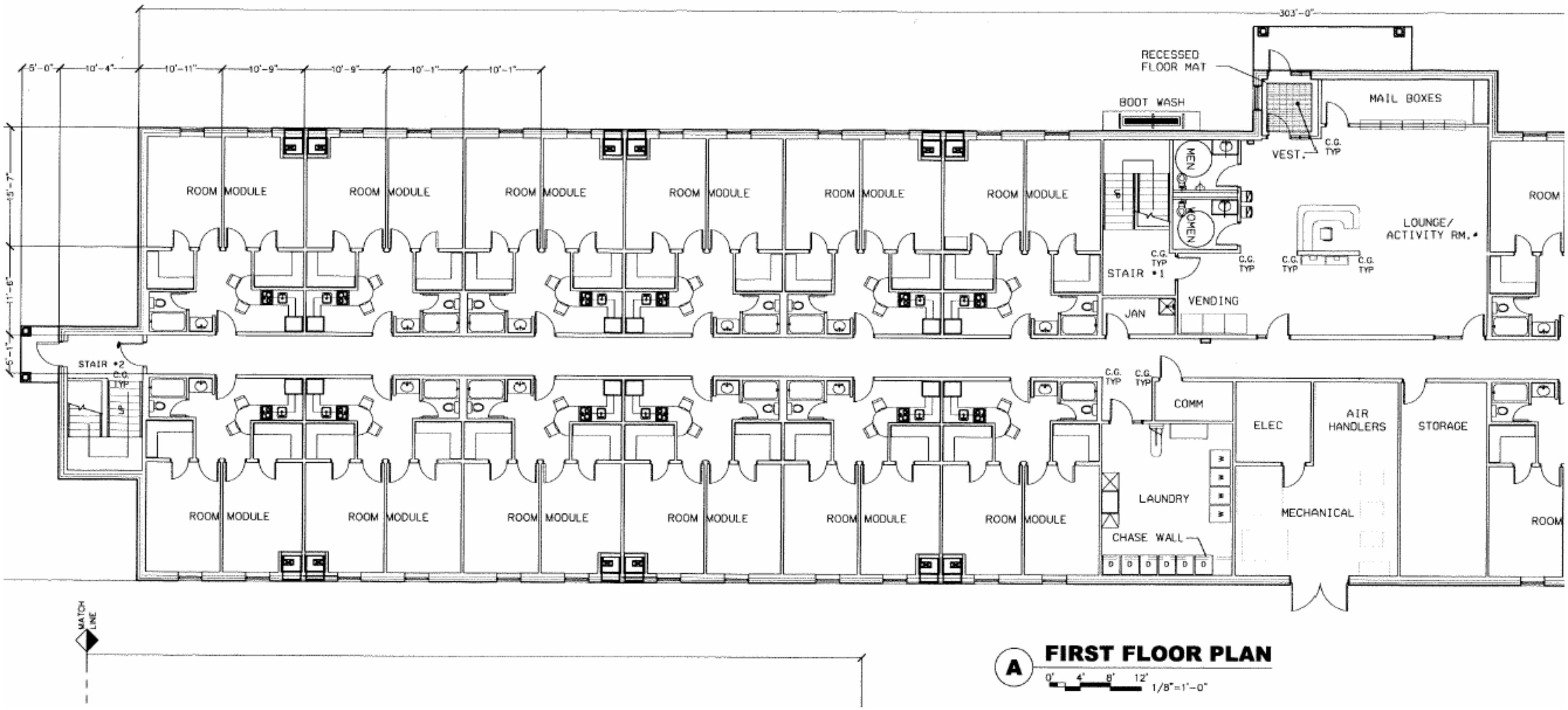
- 30% better requirement with Contractor's option of any one of the three Army EPACT compliance paths
- Building envelope tightness requirement [.25 cfm/ft^2 of envelope area at .3 iwg (75Pa)] and requirement to perform pressure test and thermography to confirm tightness on completed construction

Permanent Party Barracks Results

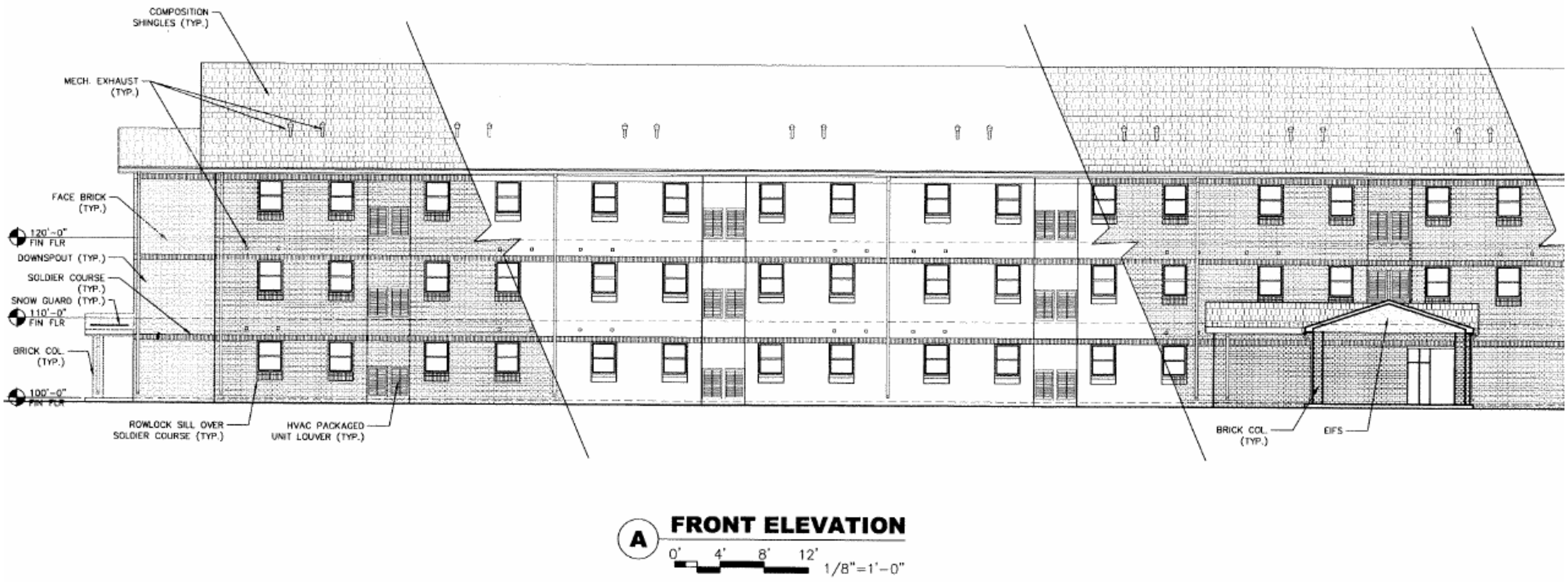
Permanent Party Barracks

- Standard Barracks Design provided by Corps Center Of Standardization - Ft Worth District
- Baseline (90.1-2004) assumptions provided by ASHRAE advisory committee
- Schedule assumptions and new technology suggestions provided by ERDC
- Analyses performed by NREL using EnergyPlus

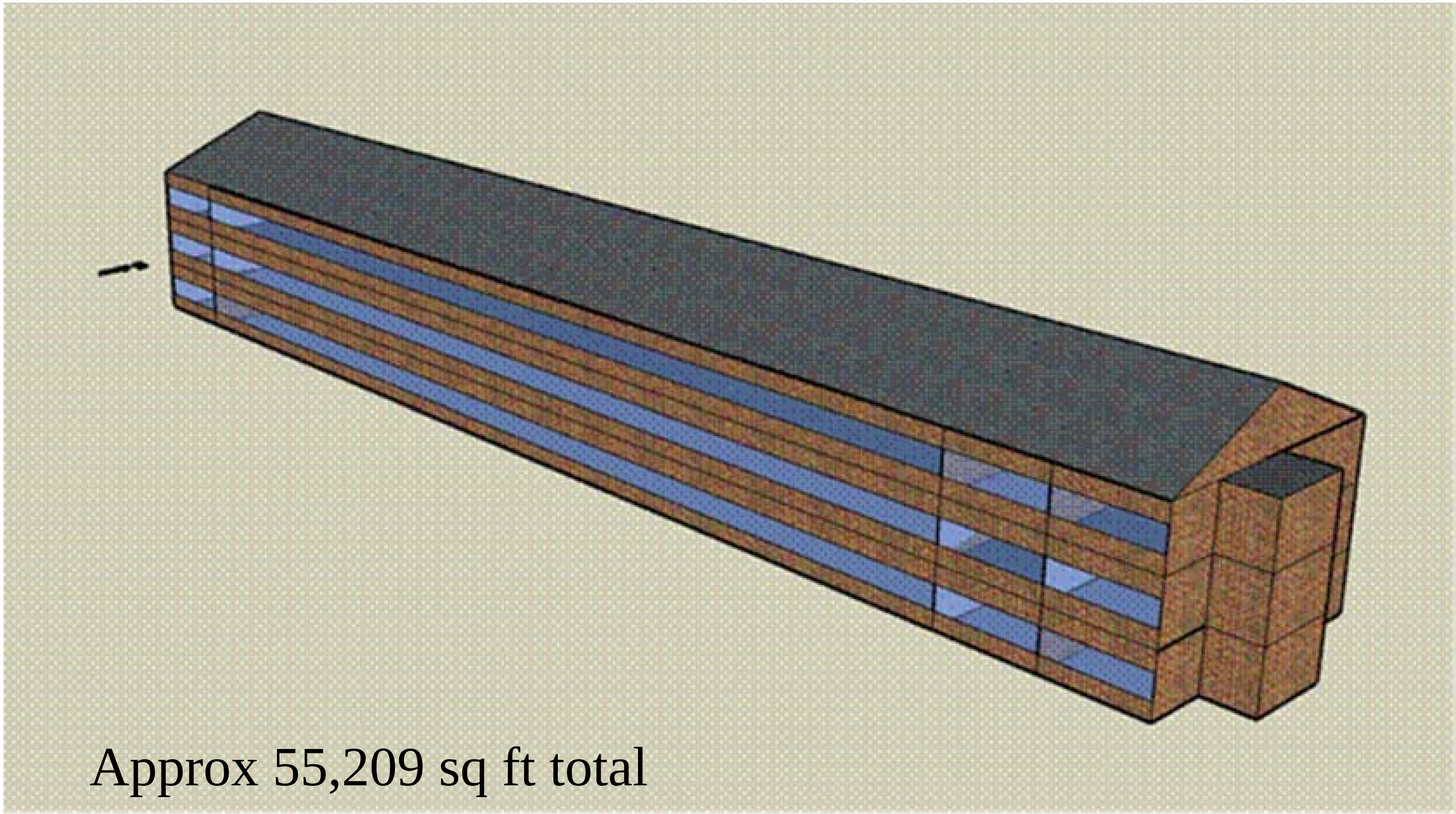
Barracks First Floor Plan



Barracks Elevation



Barracks EnergyPlus Rendering



Barracks Model Assumptions

Parameter	Baseline Model	Energy Efficient Model
Orientation	Set to 0º	Same as baseline
Windows	20% window-to-wall ratio	Same as baseline
Wall Construction	Steel frame	Same as baseline
Roof Construction	Flat roof with insulation entirely above deck	Naturally vented attic with the insulation at the ceiling level
Infiltration	0.4 cfm/ft^2 @ 75 Pa (proposed Standard 90.1 -2004 addendum Z)	0.25 cfm/ft^2 @ 75 Pa (proposed Army standard)
Ventilation	Make up for bathroom exhaust at 90 cfm plus flow for building pressurization to 5 Pa at the baseline infiltration rate	Make up for bathroom exhaust at 90 cfm plus flow for building pressurization to 5 Pa at the proposed Army infiltration rate

Barracks Model Assumptions

	0.4 cfm/ft^2	0.25 cfm/ft^2
ACH at 75 Pa	1.51	0.62
ACH at 5 Pa	0.22	0.09
Excess ventilation flow at 5 Pa (cfm)	2,950	1,211
Excess ventilation flow at 5 Pa (L/s)	1,392	572

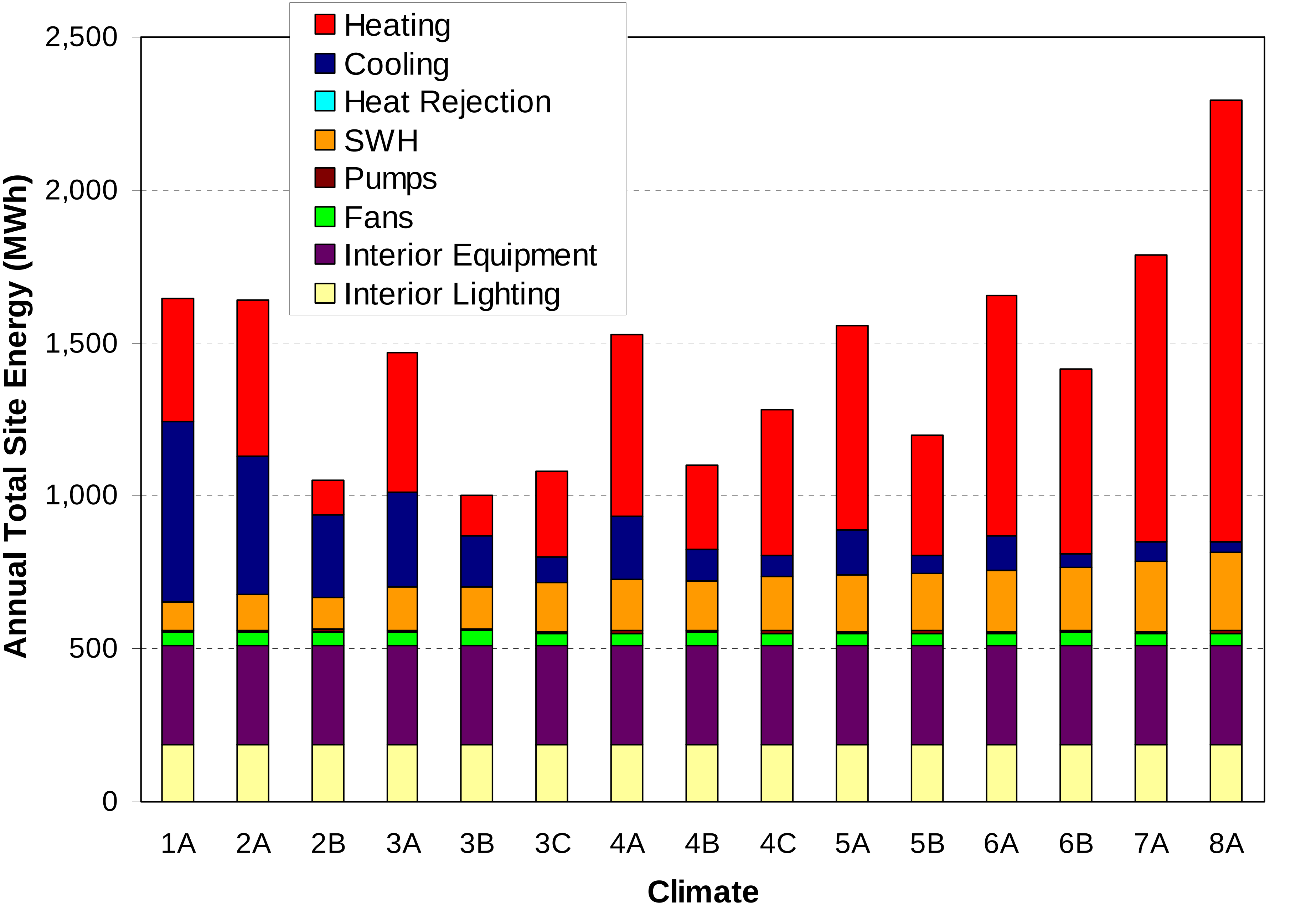
Barracks Model Assumptions

Parameter	Baseline Model	Energy Efficient Model
Temp set points	70 heating; 75 cooling with no setback	Same as baseline
Humidity Control	Zone humidistat at 50% RH	Humidity controlled with DOAS with room cooling coil temperature control
Interior Lighting	1.1 W/ft^2 in the rooms, 0.5 W/ft^2 in the corridors	0.9 W/ft^2 in the rooms, 0.45 W/ft^2 in the corridors
Plug loads	1.7 W/ft^2 plus refrigerator and range (See schedules in Appendix A)	Same as baseline
Hot Water Load	See calculations in report	Same as baseline with grey water heat recovery
Schedules	See Tables in RFP	Same as baseline

Barracks Design Energy Targets

Climate Zone	City	Energy Budget (kBtu/ft^2)	
		ASHRAE 90.1-2004 Building	EPACT 2005 Target (no plug loads)
1A	Miami, FL	82	58
2A	Houston, TX	82	57
2B	Phoenix, AZ	45	32
3A	Memphis, TN	71	50
3B	El Paso, TX	42	30
3C	San Francisco, CA	47	33
4A	Baltimore, MD	75	52
4B	Albuquerque, NM	48	34
4C	Seattle, WA	60	42
5A	Chicago, IL	77	54
5B	Colorado Springs, CO	54	38
6A	Burlington, VT	83	58
6B	Helena, MT	68	47
7A	Duluth, MN	91	64
8A	Fairbanks, AK	123	86

Baseline Energy Consumption by End Use



Energy Conservation Measures

	Baseline Models	Efficient Models
Wall Insulation	Standard 90.1-2004	Higher R-Values (see RFP)
Roof Insulation	Standard 90.1-2004	Higher R-Values (see RFP)
Roof Solar Reflectance	0.08	0.27
Window-to-Wall Ratio	20%	20%
Window Construction	Standard 90.1-2004	ASHRAE AEDG 30% Small Offices
Infiltration	0.4 cfm/ft^2 @ 75 Pa	0.25 cfm/ft^2 @ 75 Pa
Ventilation	Exhaust plus make-up air for infiltration at 5 Pa	Same as baseline but reduced make-up air for the tighter building

Energy Conservation Measures

	Baseline Models	Efficient Models
Lighting	1.1 W/ft^2 in rooms, 0.5 in corridors, 0.6 in stairwells	0.9 W/ft^2 in rooms, 0.45 in corridors, 0.54 in stairwells
SWH Boiler Efficiency	80%	95%
Grey water heat recovery	None	Assumed 30% savings on shower hot water
HVAC Systems	Packaged Single Zone with DX coil (3.05 COP) for cooling and natural gas coil (80% efficient) for heating	DOAS with DX coil (3.5 COP) and ERV (75%-70% sensible effectiveness) and hot water coil, 4-pipe fan coil with central chiller and boiler

Energy Efficient Solution Results

Zone	City	ASHRAE 90.1-2004 Building Energy Budget (kBtu/ft^2)	EPACT 2005 Building Energy Budget (kBtu/ft^2)	Government Furnished Example Technology Solution SET to meet EPACT 2005	
				Energy Budget (kBtu/ft^2)	Energy Savings versus ASHRAE Bldg
1A	Miami, FL	82	58	40	51%
2A	Houston, TX	82	57	37	55%
2B	Phoenix, AZ	45	32	32	30%
3A	Memphis, TN	71	50	35	51%
3B	El Paso, TX	42	30	30	30%
3C	San Francisco, CA	47	33	26	45%
4A	Baltimore, MD	75	52	32	57%
4B	Albuquerque, NM	48	34	29	40%
4C	Seattle, WA	60	42	27	55%

Energy Efficient Solution Results

Zone	City	ASHRAE 90.1-2004 Building Energy Budget (kBtu/ft^2)	EPACT 2005 Building Energy Budget (kBtu/ft^2)	Government Furnished Example Technology Solution SET to meet EPACT 2005	
				Energy Budget (kBtu/ft^2)	Energy Savings versus ASHRAE Bldg
5A	Chicago, IL	77	54	32	58%
5B	Colorado Springs, CO	54	38	28	48%
6A	Burlington, VT	83	58	32	61%
6B	Helena, MT	68	47	29	57%
7A	Duluth, MN	91	64	33	64%
8A	Fairbanks, AK	123	86	42	66%

Barracks Climate Zone 3A
Government Furnished Example Technology Set

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Item	Component	ASHRAE 90.1-2004 Bldg [1]	Gov Furnished Example Bldg
Roof	Attic	R-30	R-40
	Surface reflectance	0.08	0.27
Walls	Light Weight Construction	R-13	R-20
Floors	Mass	R-6.3 c.i.	R-10 c.i.
Slabs	Unheated	NR [2]	NR [2]
Doors	Swinging	U-0.70	U-0.70
	Non-Swinging	U-1.45	U-1.45
Infiltration		0.4 cfm/ft^2 @ 75 Pa	0.25 cfm/ft^2 @ 75 Pa [3]
Vertical Glazing	Window to Wall Ratio (WWR)	10% - 20%	10% - 20%
	Thermal transmittance	U-0.57	U-0.45
	Solar heat gain coefficient (SHGC)	0.37	0.31

Barracks Climate Zone 3A
Government Furnished Example Technology Set (cont)

DRAFT

Item	Component	ASHRAE 90.1-2004 Bldg [1]	Gov Furnished Example Bldg
Interior Lighting	Lighting Power Density (LPD)	1.1W/ft^2	0.9 W/ft^2
	Ballast		Electronic ballast
HVAC	Air Conditioner	PSZ-AC 12.0 SEER (3.05 COP)	4-Pipe Fan Coil with central chiller and boiler plus DOAS [4] with 14.0 SEER DX coil (3.52 COP) and HHW coil on central boiler SAT control 55ºF – 62ºF with OAT 75º – 54ºF
	Gas Furnace	80% E_t	none
	ERV	None	70% - 75% sensible effectiveness

Barracks Climate Zone 3A
Government Furnished Example Technology Set (cont)

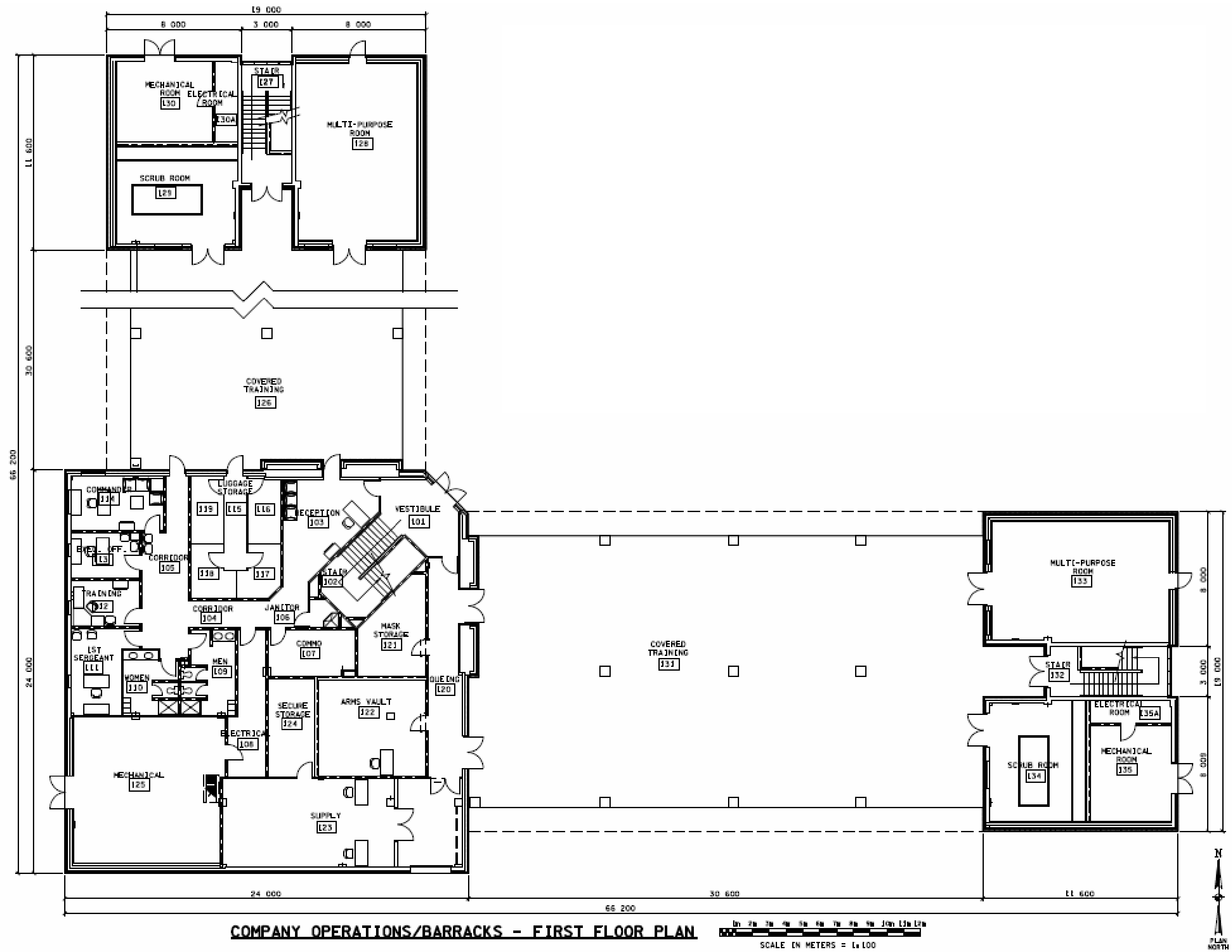
DRAFT

Item	Component	ASHRAE 90.1-2004 Bldg [1]	Gov Furnished Example Bldg
Economizer Ventilation		NR	NR
	Outdoor Air Damper	Motorized control	Motorized control
	Demand Control	NR	NR
Ducts	Laundry Room		Decoupled [5]
	Sealing		Seal class B
	Location		Interior only
Service Water Heating	Insulation level		R-6 [6]
	Gas storage	80% E_t	90% E_t
	Drain Water Heat Recovery	None	Showers only - 30% effic [7]

Training Barracks (BT) Results

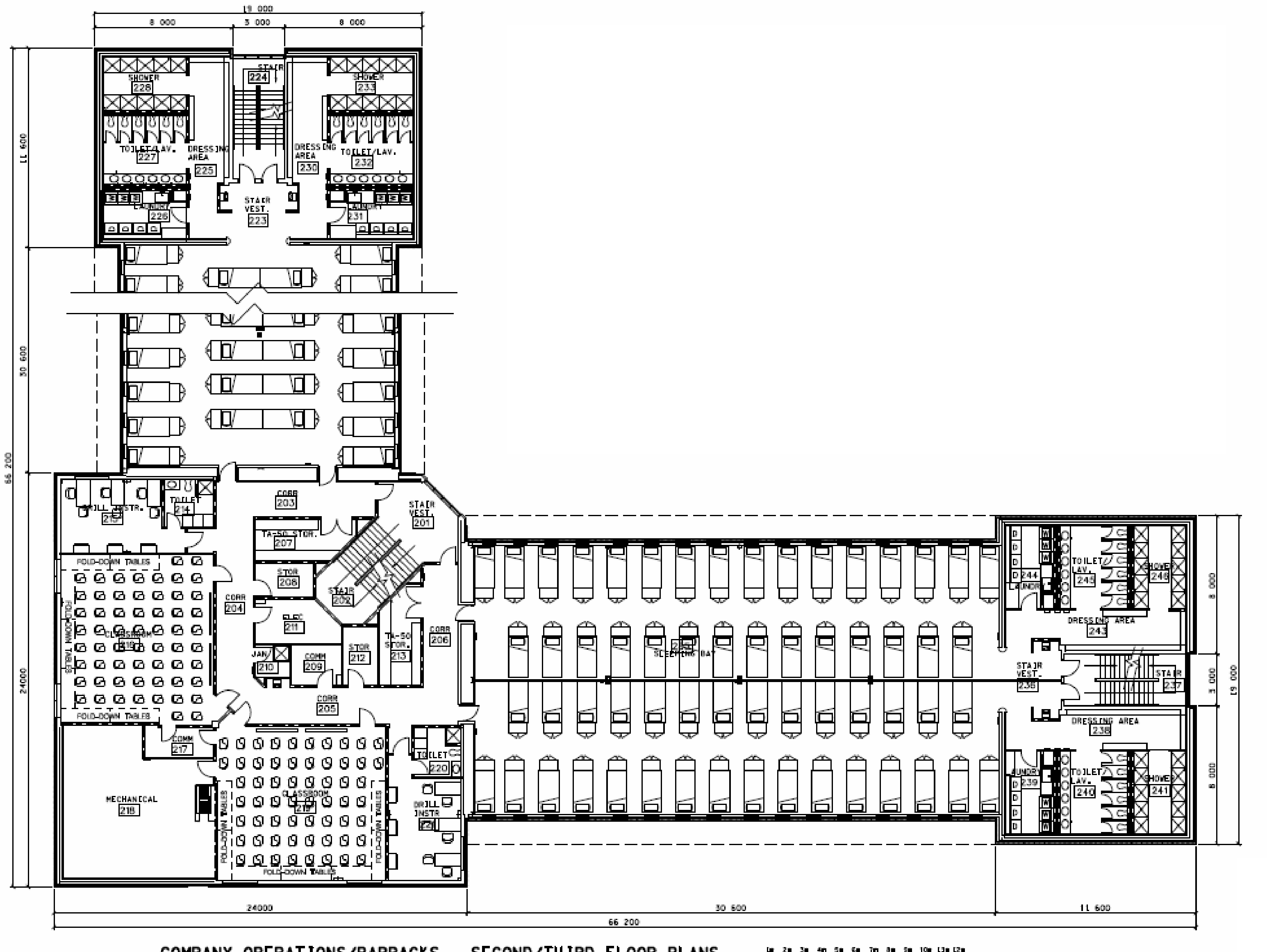
- BT Design provided by Corps Center Of Standardization – Ft Worth District
- Baseline (90.1-2004) assumptions provided by ASHRAE advisory committee
- Schedule assumptions and new technology suggestions provided by ERDC
- Analyses performed by NREL using EnergyPlus

BT 1st Floor



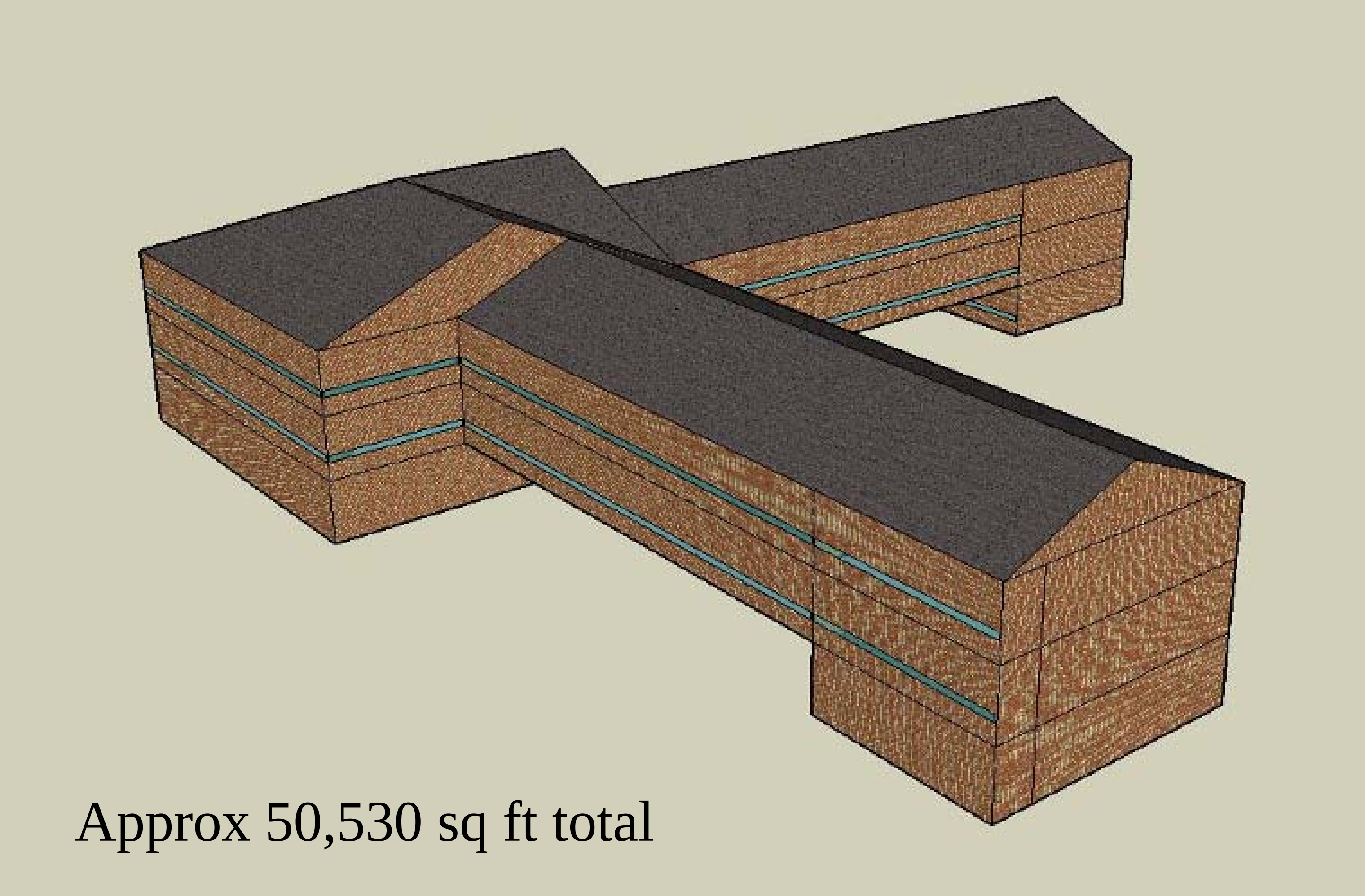
19 000
8 000
3 000
8 000
MECHANICAL ROOM 130
ELECTRICAL ROOM 130A
STAIR 127
MULTI-PURPOSE ROOM 128
SCRUB ROOM 129
COVERED TRAINING 126
COMMANDER 114
EXEC. OFF. 113
CORRIDOR 105
TRAINING 112
1ST SERGEANT 111
WOMEN 110
MEN 109
LUGGAGE STORAGE
119
115
116
118
117
RECEPTION 103
VESTIBULE 101
STAIR 102
CORRIDOR 104
JANITOR 106
COMMO 107
MASK STORAGE 121
QUEUING 120
SECURE STORAGE 124
ARMS VAULT 122
ELECTRICAL 108
MECHANICAL 125
SUPPLY 123
COVERED TRAINING 131
MULTI-PURPOSE ROOM 133
STAIR 132
ELECTRICAL ROOM 135A
SCRUB ROOM 134
MECHANICAL ROOM 135
24 000
30 600
11 600
66 200
COMPANY OPERATIONS/BARRACKS - FIRST FLOOR PLAN
SCALE IN METERS = 1:100
PLAN NORTH

BT 2nd & 3rd Floors



COMPANY OPERATIONS/BARRACKS – SECOND/THIRD FLOOR PLANS

BT Analysis



BT Model Assumptions

Parameter	Baseline Model	Energy Efficient Models
Orientation	Set to 45º	Same as baseline
Windows	20% window-to-wall ratio	Same as baseline
Wall Construction	Steel frame	Same as baseline
Roof Construction	Flat roof with insulation entirely above deck	Naturally vented attic with the insulation at the ceiling level
Infiltration (Section 4.1)	0.4 cfm/ft^2 @ 75 Pa (Proposed standard 90.1 -2004 addendum Z)	0.25 cfm/ft^2 @ 75 Pa (Army standard)
Ventilation (Section 4.2)	3000 cfm per wing and floor - exhaust + 10% continuous	Reduce exhaust to follow dryer operation
Temp set points	70 heating; 75 cooling – constant in sleeping areas, set back in office and classroom areas	Same as baseline
Humidity Control	Zone humidistat at 50% RH	Humidity controlled with cooling coil temperature control
Plug loads		Same as baseline
Washers and dryers (Section 4.5)	Commercial grade EnergyStar rated models	Same as baseline
Hot water load (Section 4.4)	5 min/shower, once per day following morning PT; washing machines used in the evenings at 4 lb/person (RFP page A08 for showers)	Same as baseline
Schedules		Same as baseline

BT Design Energy Targets

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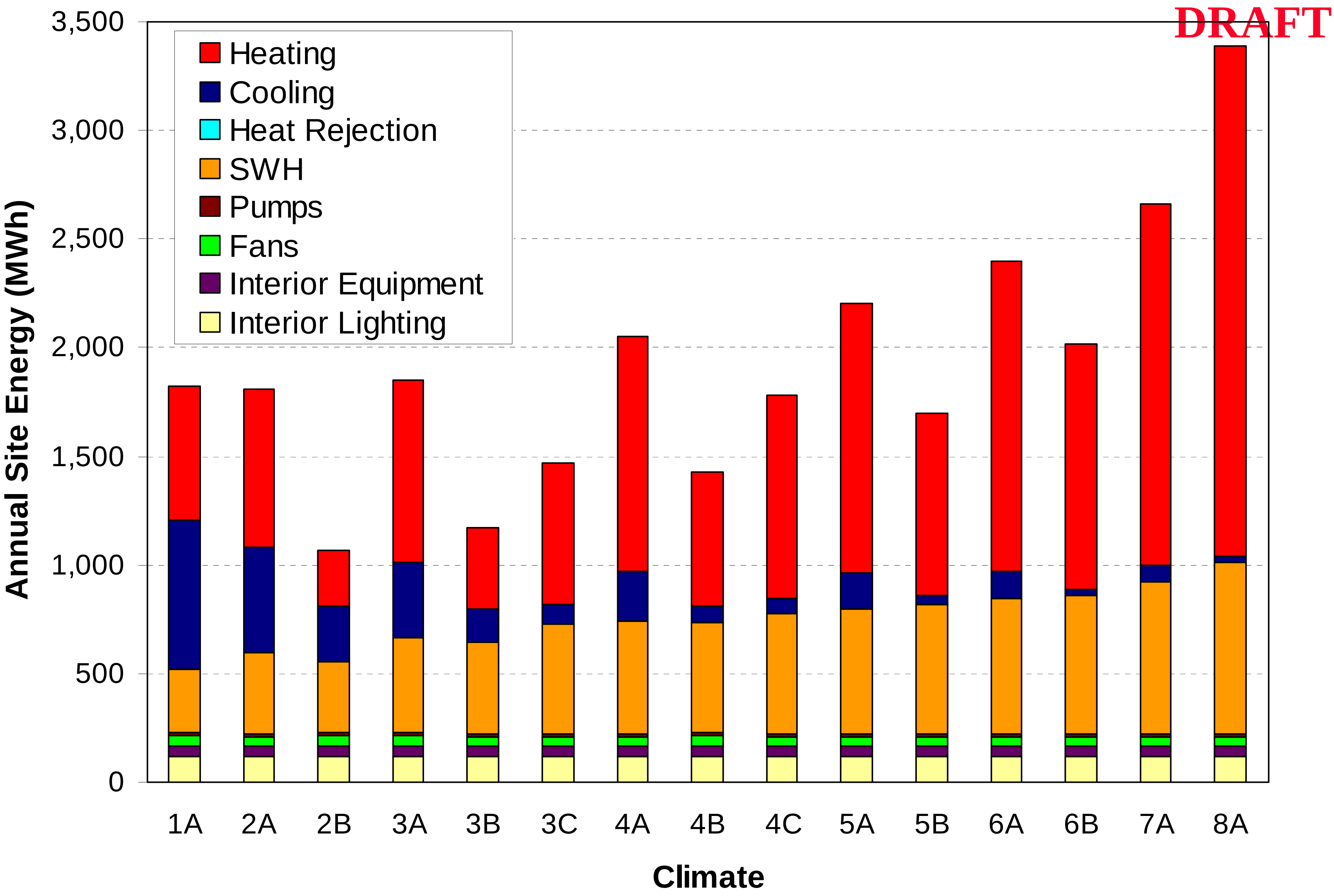
Climate Zone	City	Energy Budget (kBtu/ft²)	
		ASHRAE 90.1-2004 Building	EPACT 2005 Target Building
1A	Miami, FL	120	84
2A	Houston, TX	119	83
2B	Phoenix, AZ	69	48
3A	Memphis, TN	122	85
3B	El Paso, TX	76	53
3C	San Francisco, CA	96	67
4A	Baltimore, MD	135	95
4B	Albuquerque, NM	93	65
4C	Seattle, WA	117	82
5A	Chicago, IL	146	102
5B	Colorado Springs, CO	111	78
6A	Burlington, VT	159	111
6B	Helena, MT	133	93
7A	Duluth, MN	176	123
8A	Fairbanks, AK	225	158

BT Baseline Buildings



BT Energy Conservation Measures

	Baseline Models	Efficient Models
Wall construction & insulation	Steel frame and Standard 90.1-2004 levels	Steel frame and higher R-values (Table 8)
Roof Construction	Insulation above deck Standard 90.1-2004	Attic with slopped metal roof
Roof Solar Reflectance	0.08	0.27
Window-to-Wall Ratio	10%	10%
Window Construction	Standard 90.1-2004	ASHRAE AEDG 30% Small Offices
Infiltration	0.4 cfm/ft^2 @ 75 Pa	0.25 cfm/ft^2 @ 75 Pa
Lighting	1 W/ft^2	0.9 W/ft^2
SWH Boiler Efficiency	80%	90%
Grey water heat recovery	None	Assumed 30% savings on shower hot water
HVAC Systems	Packaged Single Zone with DX coil (3.05 COP) for cooling and natural gas coil (80% efficient) for heating	DOAS with DX coil (3.5 COP) and ERV (75%-70% sensible effectiveness) and hot water coil, 4-pipe fan coil with central chiller and boiler, separate ventilation for laundry rooms

BT Energy Eff Bldg w/o plug loads

Zone	City	Baseline (kBtu/ft²)	Envelope Only ECMs		Envelope, HVAC, and Grey Water HR ECMs	
			(kBtu/ft²)	Savings	(kBtu/ft²)	Savings
1A	Miami, FL	120	87	27%	45	63%
2A	Houston, TX	119	92	23%	58	51%
2B	Phoenix, AZ	69	58	15%	41	41%
3A	Memphis, TN	122	99	19%	60	50%
3B	El Paso, TX	76	66	13%	53	32%
3C	San Francisco, CA	96	86	10%	42	56%
4A	Baltimore, MD	135	109	19%	64	53%
4B	Albuquerque, NM	93	79	16%	55	41%
4C	Seattle, WA	117	99	15%	58	50%
5A	Chicago, IL	146	123	16%	70	52%
5B	Colorado Springs, CO	111	96	14%	62	44%
6A	Burlington, VT	159	136	14%	72	55%
6B	Helena, MT	133	114	14%	66	51%
7A	Duluth, MN	176	153	13%	78	56%
8A	Fairbanks, AK	225	199	11%	94	58%

TRAINING BARRACKS Climate Zone 3A
Government Furnished Example Technology Set

DRAFT

Item	Component	ASHRAE 90.1-2004 Bldg 1	Gov Furnished Example Bldg
Roof	Attic	R-30	R-40
	Surface reflectance	0.08	0.27
Walls	Light Weight Construction	R-13	R-20
Floors	Mass	R-6.3 c.i.	R-10 c.i.
Slabs	Unheated	NR 2	NR 2
Doors	Swinging	U-0.70	U-0.70
	Non-Swinging	U-1.45	U-1.45
Infiltration		0.4 cfm/ft^2 @ 75 Pa	0.25 cfm/ft^2 @ 75 Pa 3
Vertical Glazing	Window to Wall Ratio (WWR)	10% - 20%	10% - 20%
	Thermal transmittance	U-0.57	U-0.45
	Solar heat gain coefficient (SHGC)	0.37	0.31

TRAINING BARRACKS Climate Zone 3A Government Furnished Example Technology Set (cont)

DRAFT

Item	Component	ASHRAE 90.1-2004 Bldg [1]	Gov Furnished Example Bldg
Interior Lighting	Lighting Power Density (LPD)	1.1 W/ft^2	0.9 W/ft^2
	Ballast		Electronic ballast
HVAC	Air Conditioner	PSZ-AC 12.0 SEER (3.05 COP)	4-Pipe Fan Coil with central chiller and boiler plus DOAS [4] with 14.0 SEER DX coil (3.52 COP) and HHW coil on central boiler SAT control 55ºF – 62ºF with OAT 75º – 54ºF
	Gas Furnace	80% E_t	none
	ERV	None	70% - 75% sensible effectiveness

TRAINING BARRACKS Climate Zone 3A Government Furnished Example Technology Set (cont)

DRAFT

Item	Component	ASHRAE 90.1-2004 Bldg [1]	Gov Furnished Example Bldg
Economizer Ventilation		NR	NR
	Outdoor Air Damper	Motorized control	Motorized control
	Demand Control	NR	NR
Ducts	Laundry Room		Decoupled [5]
	Sealing		Seal class B
	Location		Interior only
Service Water Heating	Insulation level		R-6 [6]
	Gas storage	80% E_t	90% E_t
	Drain Water Heat Recovery	None	Showers only - 30% effic [7]

BT Results Summary

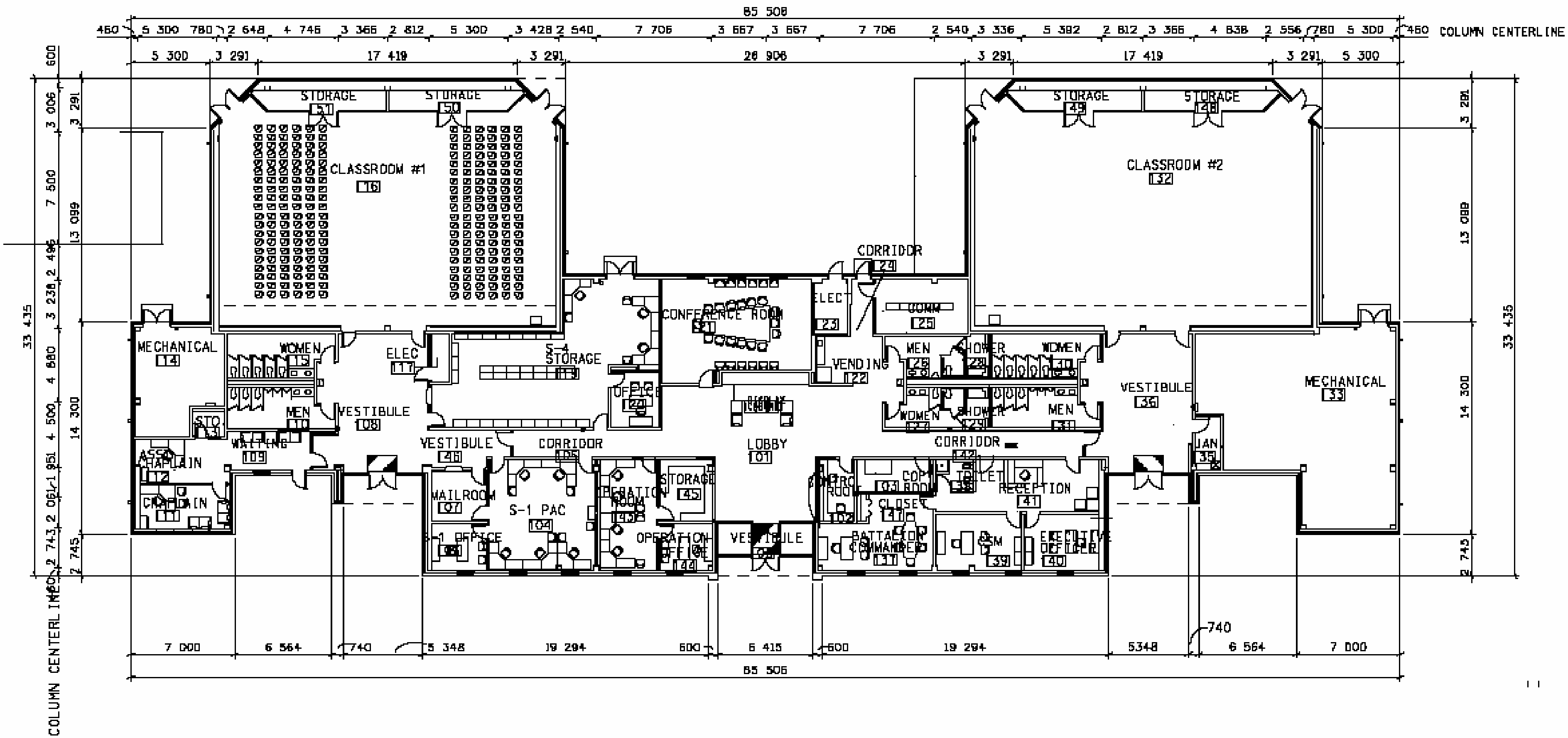
Zone	City	ASHRAE 90.1-2004 Building Energy Budget (kBtu/ft^2)	EPACT 2005 Building Energy Budget (kBtu/ft^2)	Government Furnished Example Technology Solution SET to meet EPACT 2005			
				Energy Budget (kBtu/ft^2)	Energy Savings versus ASHRAE Bldg	LEED Points for EA1, EQ2, EQ6.2, EQ7.1	Potential EPACT Tax Deduction for Designer
1A	Miami, FL	120	84	45	63%	13	Yes
2A	Houston, TX	119	83	58	51%	13	Yes
2B	Phoenix, AZ	69	48	41	41%	12	No
3A	Memphis, TN	122	85	60	50%	13	Yes
3B	El Paso, TX	76	53	53	32%	10	No
3C	San Francisco, CA	96	67	42	56%	13	Yes
4A	Baltimore, MD	135	95	64	53%	13	Yes
4B	Albuquerque, NM	93	65	55	41%	12	No
4C	Seattle, WA	117	82	58	50%	13	Yes
5A	Chicago, IL	146	102	70	52%	13	Yes
5B	Colorado Springs, CO	111	78	62	44%	13	No
6A	Burlington, VT	159	111	72	55%	13	Yes
6B	Helena, MT	133	93	66	51%	13	Yes
7A	Duluth, MN	176	123	78	56%	13	Yes
8A	Fairbanks, AK	225	158	94	58%	13	Yes

Administrative Facility (BHQ) Results

Battalion Headquarters

- Standard BHQ Design provided by Corps Center Of Standardization - Savannah District
- Baseline (90.1-2004) assumptions provided by ASHRAE advisory committee
- Schedule assumptions and new technology suggestions provided by ERDC-CERL
- Analyses performed by NREL using EnergyPlus

BHQ Floor Plan



BHQ Analysis

- ASHRAE Advanced Energy Design Guide for Small Office Buildings applicable
  - 30% better than 90.1-1999
  - Design improvement tables for each of the eight major DOE climate zones in U.S.

ASHRAE AEDG for Small Offices

Climate Zone 3 Recommendation Table

Item	Component	Recommendation	Notes and Details
Roof	Insulation Entirely Above Deck	R-20 c.i.	EN1-2, 17, 20-21
	Metal Building	R-13 + R-13	EN1, 3, 17, 20-21
	Attic and Other	R-38	EN4, 17-18, 20-21
	Single Rafter	R-38	EN5, 17, 20-21
	Surface reflectance/emittance	0.65 Initial/0.86	EN1
Walls	Mass (HC > 7 Btu/ft^2)	R-9.5 c.i.	EN6, 17, 20-21
	Metal Building	R-13	EN7, 17, 20-21
	Steel Framed	R-13 + R-3.8 c.i.	EN8, 17, 20-21
	Wood Framed and Other	R-13	EN9, 17, 20-21
	Below Grade Walls	No recommendation	EN10, 17, 20-21
Floors	Mass	R-8.3 c.i.	EN11, 17, 20-21
	Steel Framed	R-19	EN12, 17, 20-21
	Wood Framed and Other	R-30	EN12, 17, 20-21
Slabs	Unheated	No recommendation	EN17, 19-21
	Heated	No recommendation	EN17, 19-21
Doors	Swinging	U-0.70	EN15, 20-21
	Non-Swinging	U-1.45	EN16, 20-21
Vertical Glazing	Window to Wall Ratio (WWR)	20% to 40% max	EN23, 36-37
	Thermal transmittance	U-0.45	EN25
	Solar heat gain coefficient (SHGC)	N, S, E, W / N only	EN27-28
		0.31 / 0.46	
	Window Orientation	$(A_N * SHGC_N + A_S * SHGC_S) \geq (A_E * SHGC_E + A_W * SHGC_W)$	A_x–Window area for orientation x EN26-32
	Exterior Sun Control (S, E, W only)	Projection Factor ≥ 0.5	EN24, 28, 30, 36, 40, 42 DL5-6
Skylights	Maximum percent of roof area	3%	DL5-7
	Thermal transmittance	U-0.69	DL7
	Solar heat gain coefficient (SHGC)	0.19	

ASHRAE AEDG for Small Offices

Interior Lighting	Lighting Power Density (LPD)	0.9 W/ft²	EL1-2, 4, 9, 11-17
	Light Source (linear fluorescent)	90 Mean Lumens/watt	EL4, 10, 18
	Ballast	Electronic ballast	EL4
	Dimming Controls for Daylight Harvesting for WWR 25% or Higher	Dim fixtures within 12 ft of N/S window wall or within 8 ft of skylight edge	DL1, 9-11, EL7-8
	Occupancy Controls	Auto-off all unoccupied rooms	DL2, EL5, 7
	Interior room surface reflectances	80%+ on ceilings, 70%+ on walls and vertical partitions	DL3-4, EL3
HVAC	Air Conditioner (0-65 KBtuh)	13.0 SEER	HV1- 2, 4, 6, 12, 16-17, 20
	Air Conditioner (>65-135 KBtuh)	11.0 EER/11.4 IPLV	HV1- 2, 4, 6, 12, 16-17, 20
	Air Conditioner (>135-240 KBtuh)	10.8 EER/11.2 IPLV	HV1- 2, 4, 6, 12, 16-17, 20
	Air Conditioner (>240 KBtuh)	10.0 EER/10.4 IPLV	HV1- 2, 4, 6, 12, 16-17, 20
	Gas Furnace (0-225 KBtuh - SP)	80% AFUE or E_t	HV1- 2, 6, 16, 20
	Gas Furnace (0-225 KBtuh - Split)	80% AFUE or E_t	HV1- 2, 6, 16, 20
	Gas Furnace (>225 KBtuh)	80% E_c	HV1- 2, 6, 16, 20
	Heat Pump (0-65 KBtuh)	13.0 SEER/7.7 HSPF	HV1- 2, 4, 6, 12, 16-17, 20
	Heat Pump (>65-135 KBtuh)	10.6 EER/11.0 IPLV/3.2 COP	HV1- 2, 4, 6, 12, 16-17, 20
	Heat Pump (>135 KBtuh)	10.1 EER/11.0 IPLV/3.1 COP	HV1- 2, 4, 6, 12, 16-17, 20
Ventilation	Outdoor Air Damper	Motorized control	HV7-8
	Demand Control	CO_2 Sensors	HV7, 22
Ducts	Friction rate	0.08 in. w.c./100 feet	HV9, 18
	Sealing	Seal class B	HV11
	Location	Interior only	HV9
	Insulation level	R-6	HV10
SWH	Gas storage	90% E_t	WH1-4
	Gas instantaneous	0.81 EF or 81% E_t	WH1-4
	Electric storage ≤ 12 kW	EF > 0.99 – 0.0012xVolume	WH1-4
	Pipe Insulation (d<1½" / d≥1½")	1" / 1½ "	WH6

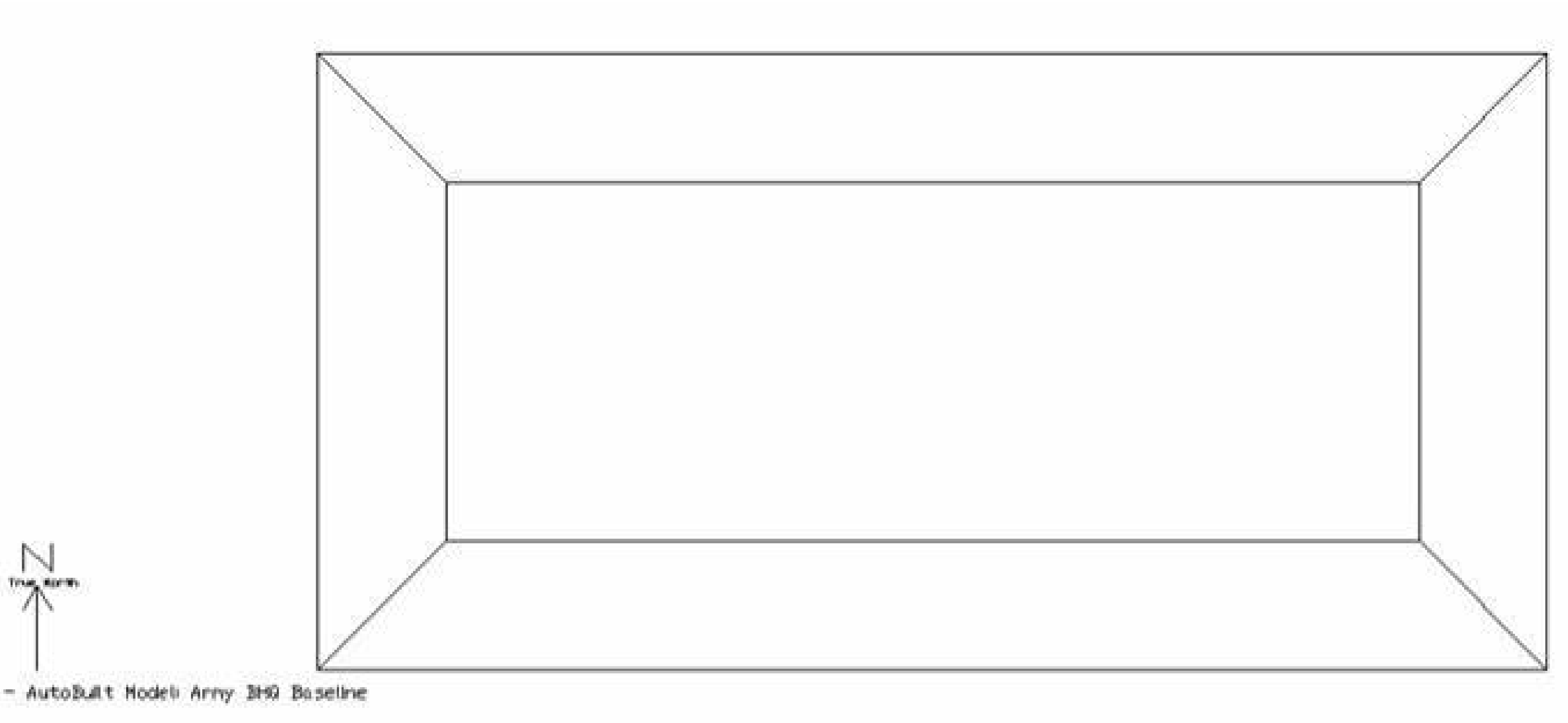
BHQ Building Description

Building Component	Baseline Building Model	Efficient Building Model
Area	10,420 ft^2 (968 m^2)	Same as baseline
Floors	1	Same as baseline
Aspect ratio	2.0	Same as baseline
Window to wall ratio	Same area as the efficient building model but uniform distribution across all facades	40% north and south, 20% east and west
Window type	Standard 90.1-2004	See Table 7
Wall construction	steel frame	steel frame
Wall insulation	Standard 90.1-2004	See Table 7
Roof construction	Sloped roof and attic with insulation at the roof level	Sloped metal roof and attic with insulation at the ceiling level
Roof insulation	Standard 90.1-2004 equal to the “insulation entirely above deck”	See Table 7
Roof albedo	0.3	0.65

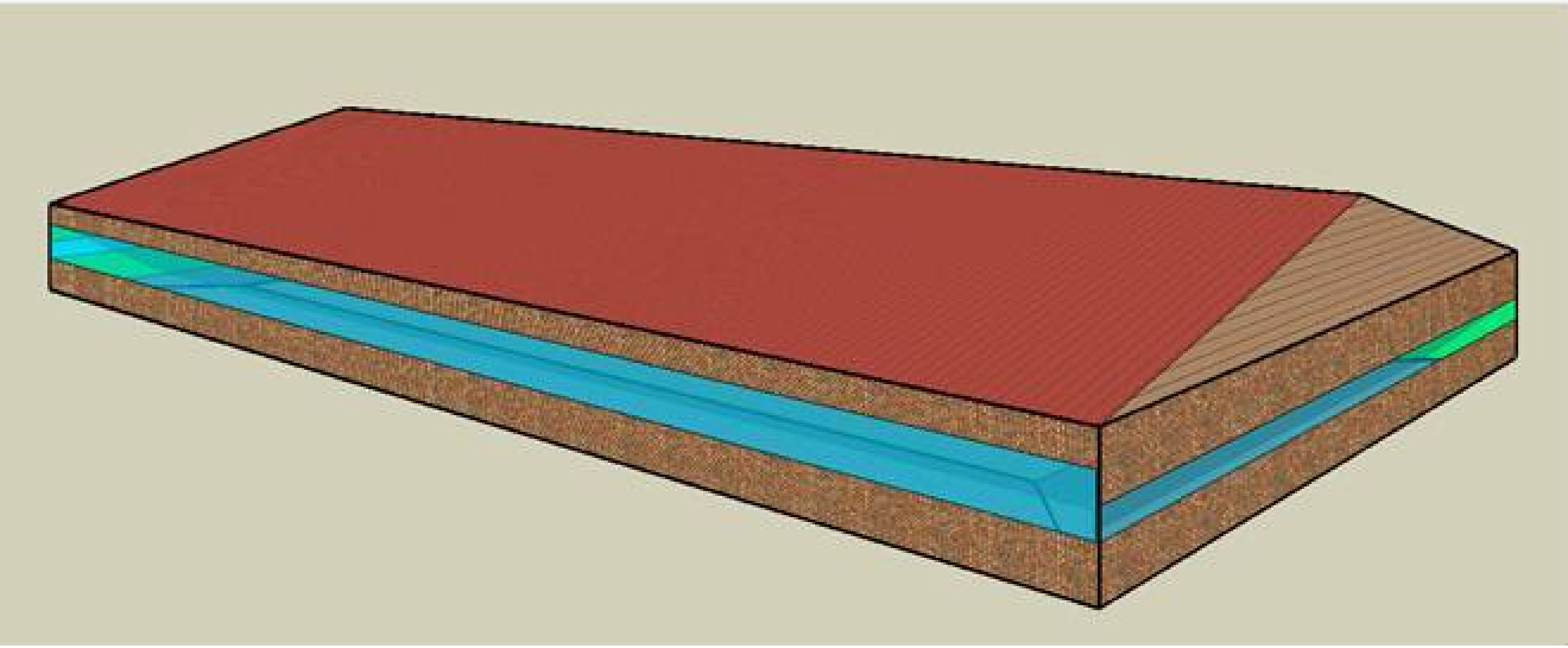
BHQ Building Description (cont)

Building Component	Baseline Building Model	Efficient Building Model
Infiltration	0.40 cfm/ft^2 @ 75 Pa (100% when outside air system is off and 10% when outside air system is on)	0.25 cfm/ft^2 @ 75 Pa (100% when outside air system is off and 10% when outside air system is on)
Lighting	1.0 W/ft^2 (10.8 W/m^2)	0.9 W/ft^2 (9.7 W/m^2) with daylighting in perimeter zones
Plug loads	0.75 W/ft^2 (8.07 W/m^2) see schedules in Appendix A	Same as baseline
Temp set points	70ºF heating; 75ºF cooling – set back when unoccupied to 55ºF heating; 91ºF cooling	Same as baseline
HVAC	PSZ with DX-AC (3.05 COP) and gas furnace (0.8 E_t)	Sys. 1: PSZ with DX-AC (3.52 COP) and gas furnace (0.9 E_t) Sys. 2: Multi-zone VAV w/ reheat, central chiller (5.0 COP) and boiler (0.8 E_t) Sys. 3: DOAS with DX dehumidification (3.52 COP), gas heating coil (0.9 E_t), ERV (70% effectiveness), 4-pipe FCUs for zone temperature control.
DHW	Natural gas boiler (0.8 E_t)	Same as baseline

BHQ Thermal Zoning



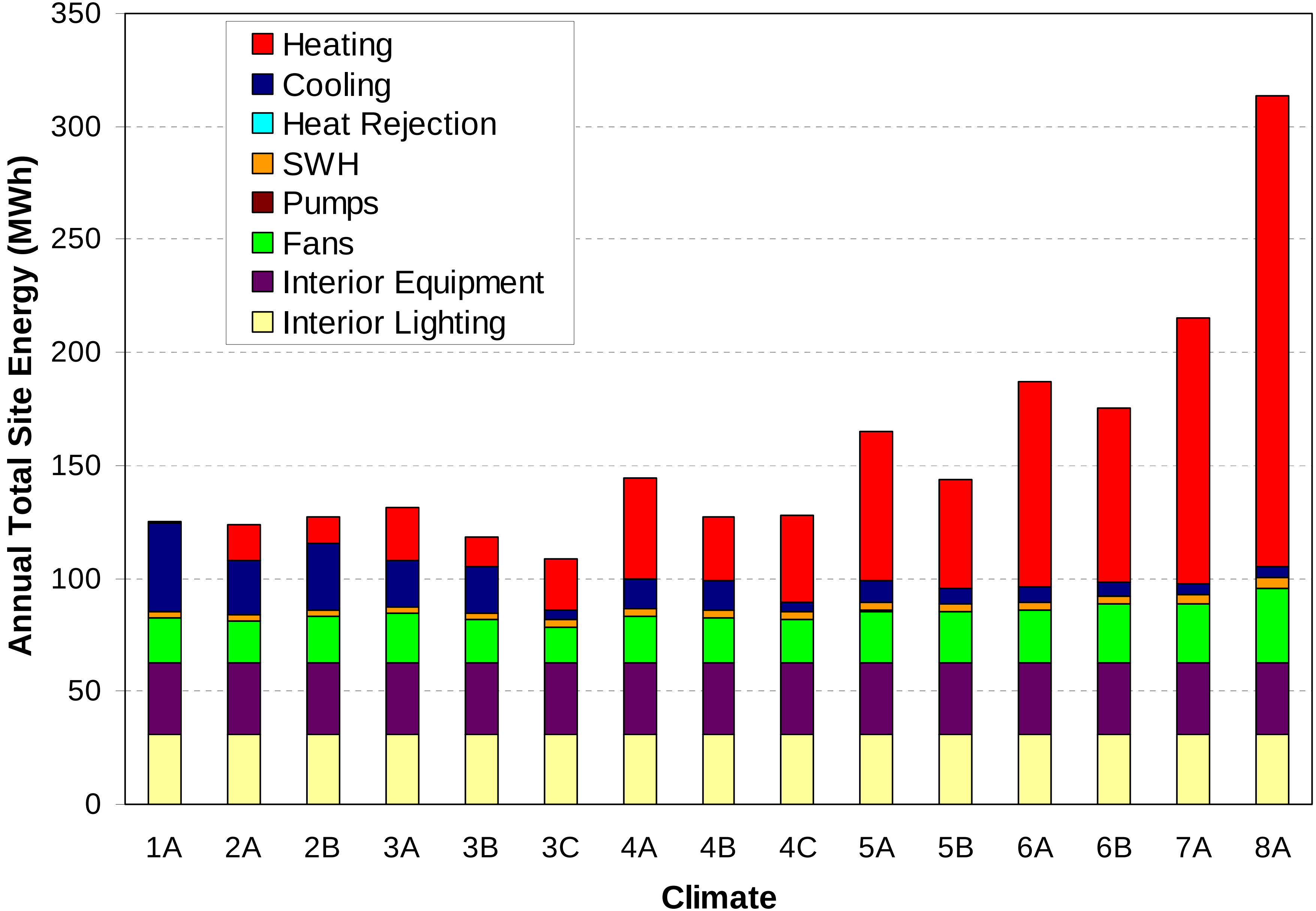
BHQ EnergyPlus Rendering



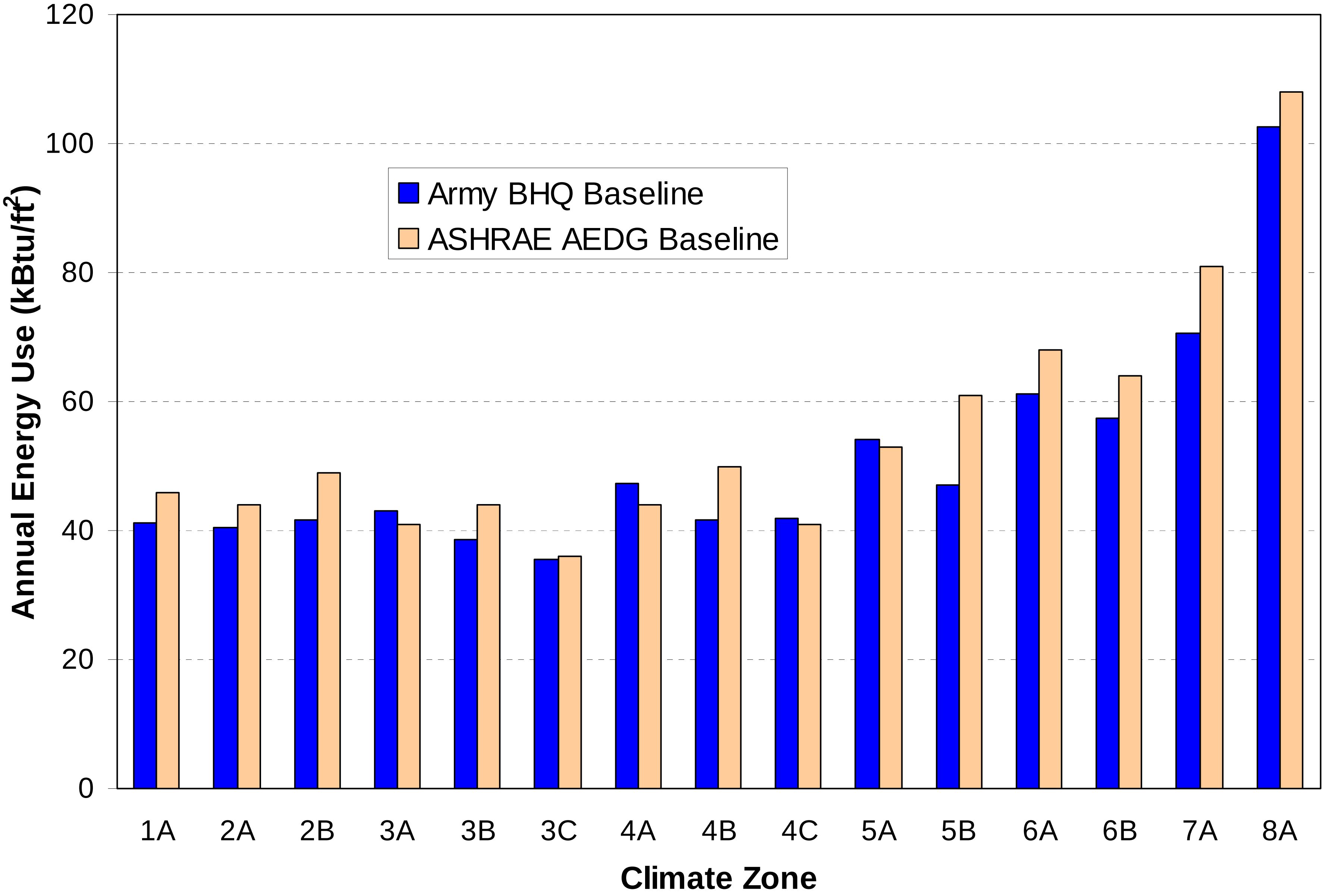
BHQ Energy Budgets (Targets) DRAFT

Climate Zone	City	With Plug Loads		Without Plug Loads	
		Baseline Energy Budget (kBtu/ft²)	Target Energy Budget (kBtu/ft²)	Baseline Energy Budget (kBtu/ft²)	Target Energy Budget (kBtu/ft²)
1A	Miami, FL	41	29	31	22
2A	Houston, TX	40	28	30	21
2B	Phoenix, AZ	42	29	31	22
3A	Memphis, TN	43	30	33	23
3B	El Paso, TX	39	27	28	20
3C	San Francisco, CA	35	25	25	18
4A	Baltimore, MD	47	33	37	26
4B	Albuquerque, NM	42	29	31	22
4C	Seattle, WA	42	29	32	22
5A	Chicago, IL	54	38	44	31
5B	Col Springs, CO	47	33	37	26
6A	Burlington, VT	61	43	51	36
6B	Helena, MT	57	40	47	33
7A	Duluth, MN	71	49	60	42
8A	Fairbanks, AK	103	72	92	65

BHQ Energy Use by End Use Baseline



Baseline: Our BHQ vs ASHRAE AEDG



BHQ ECMs

Component	Description
Envelope	Improved windows, insulation, higher albedo roof
Reduced infiltration	Reduced infiltration to 0.25 cfm/ft^2 at 0.3 in w.g.
South overhangs	Added overhangs on the south façade following the optimal dimensions determined in the Solar Radiation Data Manual for Buildings
Interior Lighting	Reduced overall LPD to 0.9 W/ft^2 and 1) added daylighting in the perimeter offices 2) added occupancy sensors in perimeter offices
High efficiency HVAC equipment	First four ECMs plus increased efficiency of the baseline HVAC system to 3.52 COP and 0.9 E_t

BHQ Energy Eff Design w/o Plug Loads

Zone	City	Baseline Energy Budget (kBtu/ft²)	Target Energy Budget (kBtu/ft²)	Prescriptive Solution (kBtu/ft²)	Prescriptive Savings %
1A	Miami, FL	28	20	19	32%
2A	Houston, TX	26	18	15	42%
2B	Phoenix, AZ	27	19	15	44%
3A	Memphis, TN	26	18	16	38%
3B	El Paso, TX	24	17	14	42%
3C	San Francisco, CA	21	15	13	38%
4A	Baltimore, MD	28	19	17	39%
4B	Albuquerque, NM	25	17	16	36%
4C	Seattle, WA	25	17	15	40%
5A	Chicago, IL	30	21	19	36%
5B	Colorado Springs, CO	26	18	16	38%
6A	Burlington, VT	33	23	20	39%
6B	Helena, MT	31	22	19	39%
7A	Duluth, MN	37	26	22	41%
8A	Fairbanks, AK	57	40	36	33%

DRAFT

Example Prescriptive Table for BHQ in Zone 3A

Item	Component	Baseline	Recommendation
Roof	Attic	R-30	R-40
	Surface reflectance	0.30	0.65
Walls	Light Weight Construction	R-13	R-20
Slabs	Unheated	NR	NR
Doors	Swinging	U-0.70	U-0.70
	Non-Swinging	U-1.45	U-1.45
Infiltration		0.4 cfm/ft² @ 75 Pa	0.25 cfm/ft² @ 75 Pa
Vertical Glazing	Window to Wall Ratio (WWR)	10% to 20% – east/west 10% to 40% – north/south	10% to 20% – east/west 10% to 40% – north/south
	Thermal transmittance	U-0.57	U-0.45
	Solar heat gain coefficient (SHGC)	0.37	0.46 – n 0.31 – s, e, & w

Example Prescriptive Table for BHQ in Zone 3A (cont)

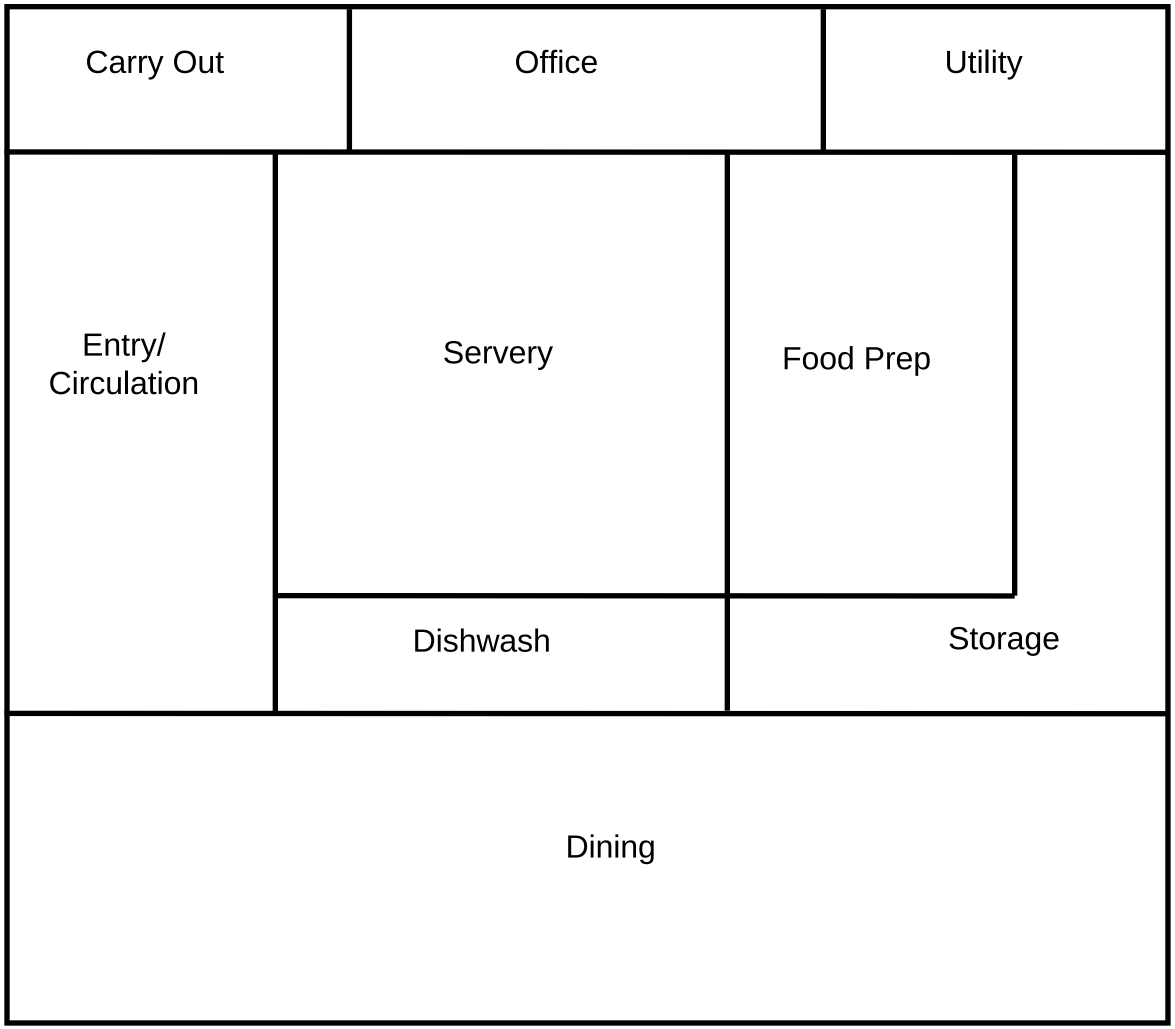
Item	Component	Baseline	Recommendation
Interior Lighting	Lighting Power Density (LPD)	1.0 W/ft^2	0.9 W/ft^2
	Ballast		Electronic ballast
	Daylighting controls	none	Perimeter zones
HVAC	Air Conditioner	PSZ-AC 12.0 SEER (3.05 COP)	PSZ-AC 14.0 SEER (3.52 COP)
	Gas Furnace	80% E_t	90% E_t
	ERV	None	None
Economizer		NR	NR
Ventilation	Outdoor Air Damper	Motorized control	Motorized control
	Demand Control	NR	NR
Ducts	Sealing		Seal class B
	Location		Interior only
	Insulation level		R-6
Service Water Heating	Gas storage	80% E_t	90% E_t

Dining Facility (DFAC) Study Results

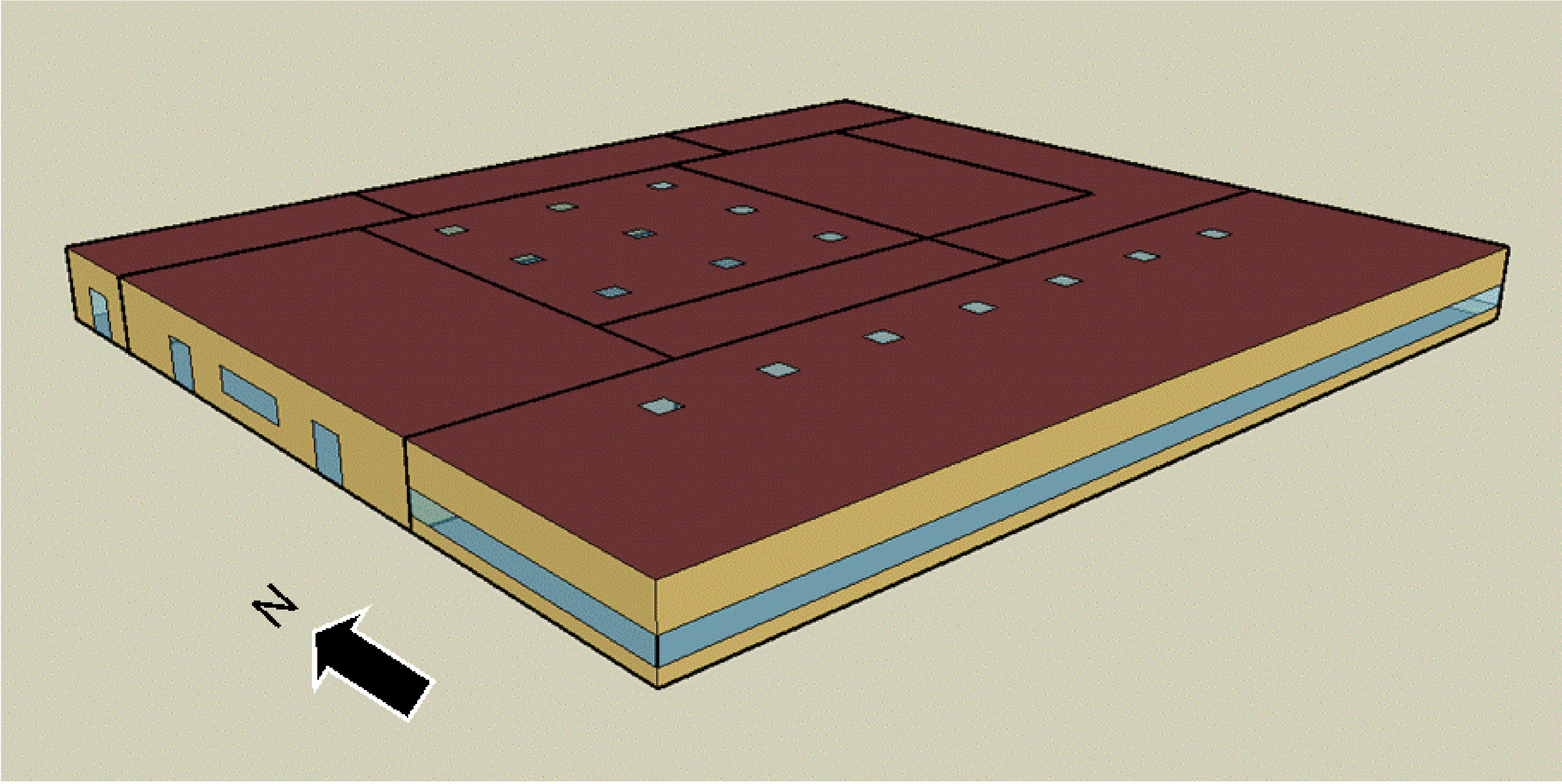
Dining Facility

- Standard DFAC Design provided by Corps Center Of Standardization - Norfolk District
- Baseline (90.1-2004) assumptions provided by ASHRAE advisory committee
- Schedule assumptions and new technology suggestions provided by ERDC-CERL
- Analyses performed by NREL using EnergyPlus

DFAC Study Zoning



DFAC EnergyPlus Rendering



DFAC Design Energy Targets

Climate Zone	City	With Plug Loads		Without Plug Loads	
		Baseline Energy Budget (kBtu/ft²)	Target Energy Budget (kBtu/ft²)	Baseline Energy Budget (kBtu/ft²)	Target Energy Budget (kBtu/ft²)
1A	Miami, FL	352	246	197	138
2A	Houston, TX	354	248	200	140
2B	Phoenix, AZ	341	239	187	131
3A	Memphis, TN	360	252	206	144
3B	El Paso, TX	343	240	189	133
3C	San Francisco, CA	313	219	159	111
4A	Baltimore, MD	381	267	227	159
4B	Albuquerque, NM	353	247	199	139
4C	Seattle, WA	347	243	193	135
5A	Chicago, IL	408	286	254	178
5B	Colorado Springs, CO	374	262	220	154
6A	Burlington, VT	434	304	280	196
6B	Helena, MT	409	286	254	178
7A	Duluth, MN	473	331	319	223
8A	Fairbanks, AK	582	407	428	300

DFAC ECMs

Envelope

Lower lighting power density (LPD)

Daylighting

Partial end panels on exhaust hoods

Replace single island hoods with back shelf hoods

High efficiency HVAC equipment

DFAC Prescriptive Solution (w/o p.lds.)

CZ	City	Baseline (kBtu/ft^2)	Final Energy Efficient Solution (kBtu/ft^2)	Energy Savings
1A	Miami, FL	197	135	32%
2A	Houston, TX	200	133	33%
2B	Phoenix, AZ	187	126	33%
3A	Memphis, TN	206	136	34%
3B	El Paso, TX	189	127	33%
3C	San Francisco, CA	159	106	33%
4A	Baltimore, MD	227	144	37%
4B	Albuquerque, NM	199	127	36%
4C	Seattle, WA	193	123	36%
5A	Chicago, IL	254	157	38%
5B	Colorado Springs, CO	220	136	38%
6A	Burlington, VT	280	171	39%
6B	Helena, MT	254	154	40%
7A	Duluth, MN	319	191	40%
8A	Fairbanks, AK	428	253	41%

DFAC Prescriptive Solution (with p.lds.)

CZ	City	Baseline ($kBtu/ft^2$)	Final Energy Efficient Solution ($kBtu/ft^2$)	Energy Savings
1A	Miami, FL	352	289	18%
2A	Houston, TX	354	287	19%
2B	Phoenix, AZ	341	280	18%
3A	Memphis, TN	360	290	19%
3B	El Paso, TX	343	281	18%
3C	San Francisco, CA	313	260	17%
4A	Baltimore, MD	381	298	22%
4B	Albuquerque, NM	353	281	20%
4C	Seattle, WA	347	277	20%
5A	Chicago, IL	408	311	24%
5B	Colorado Springs, CO	374	290	22%
6A	Burlington, VT	434	325	25%
6B	Helena, MT	409	308	25%
7A	Duluth, MN	473	345	27%
8A	Fairbanks, AK	582	407	30%

DFAC EPACT Energy Dilemma

- HVAC, Lighting, Kitchen Ventilation counts toward 30% reduction
- Kitchen cooking, refrigeration, sanitation equipment DOESNT COUNT for EPACT but uses approximately 60% of total energy!!
- MUST use Energy Star Kitchen Equipment along with good building technologies to maximize energy savings

Current Status of Army EPACT 2005 Study

- Permanent Party Barracks and TEMF complete with results implemented in Army RFPs
- Complete, reviewed results for training barracks and administrative buildings ready for implementation in MT RFPs
- Draft results for dining facilities, company operations facilities, and child development centers available
- Reserve center studies in progress

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How to Build 30% Better

Cyrus Nasseri
US Department of Energy

Thank you

- To the presenters today for sharing the successes in the field
- And to all of the presenters who have participated in the 7-part webcast series

Presenters

- Dru Crawley
- Kim Fowler
- Walter Grondzik
- Charles Gulledge
- Jennifer Helgeson
- Dale Herron
- John Hogan
- Mark Hydeman
- Ron Jarnagin
- Michael Lane
- Bobbie Lippiatt
- Cyrus Nasseri
- Kent Peterson
- Shanti Pless
- Eric Richman
- Michael Rosenberg
- Paul Torcellini
- Alexander Zhivov

FEMP 7-Part Webcast Series

- **Session 1**, Overview of Federal Building Energy Efficiency Mandates/An Introduction to Building Life-Cycle Costing
- **Session 2**, Overview of the Requirements of ANSI/ASHRAE/IESNA Standard 90.1-2004
- **Session 3**, Appendix G of 90.1-2004
- **Session 4**, Integrated Building Design: Bringing the Pieces Together to Unleash the Power of Teamwork
- **Session 5**, Sustainable Design
- **Session 6**, Advanced Energy Design Guides
- **Session 7**, How to Build 30% Better

Session 1- Overview of Federal Building Energy Efficiency Mandates/An Introduction to Building Life-Cycle Costing

- Legislative drivers - Energy Policy Act of 2005 and Energy Independence and Security Act of 2007.
- Mandate
  - New Federal buildings must achieve savings of at least 30% below ASHRAE Standard 90.1-2004 or the 2004 IECC if cost-effective.
  - Buildings must also use sustainable design principles for siting, design, and construction, if cost-effective.
  - If water is used to achieve energy efficiency, water conservation technologies shall be applied to the extent that is life-cycle cost-effective
- Use BLCC to accept/reject projects/alternatives, to find the optimal system size or combination of interdependent systems, and for ranking of independent projects.

Session 2 - Overview of the Requirements of ANSI/ASHRAE/IESNA Standard 90.1-2004

- Envelope requirements
- Lighting requirements
- Mechanical requirements

Session 3 - Appendix G of 90.1-2004

- Appendix G
  - Appendix chapter to ASHRAE Standard 90.1-2004
  - A modification of Energy Cost Budget (ECB) method
- Used For “Beyond Code Programs”
  - LEED energy points
  - Utility Programs
  - EPACT 2005 Federal Tax Incentives
  - Federal Buildings energy efficiency requirements from EPACT 2005
- Mandatory provisions of Standard 90.1-2004 are still prerequisites

Session 4 - Integrated Building Design: Bringing the Pieces Together to Unleash the Power of Teamwork

- Integrated Building Design is key to successfully reaching 30% beyond

Session 5 – Sustainable Design

- EPACT 2005 Section 109 – Federal Building Performance Standards
  - Sustainable design principles are applied to siting, design, and construction of all new and replacement buildings, when life-cycle cost-effective.
- EISA 2007 Section 433
  - New Federal buildings and Federal buildings undergoing major renovations shall apply sustainable design principles to siting, design, and construction.
  - A certification system and level for green buildings will be identified.
    - U.S. Green Building Council Leadership for Energy and Environmental Design (LEED) Silver level identified by General Services Administration on April 25, 2008
- Section 436
  - Establish an Office of Federal High-Performance Green Buildings
- Guiding Principles: Employ Integrated Design Principles; Optimize Energy Performance; Protect and Conserve Water; Enhance Indoor Environmental Quality; Reduce Environmental Impact of Materials

Session 6 – Advanced Energy Design Guides

- Envelope recommendations
- Lighting recommendations
- Mechanical recommendations

Session 7 – How to Build 30% Better

- The Army Approach
  - Clear energy goals and requirements interpretations to contractor
  - Whole building energy and IAQ optimization
    - Use of new or alternative technologies
  - Reduced design costs
  - Verifiable design objectives
  - Reduced quality control costs
  - Economy of scale in purchasing process
- BETTER ARMY BUILDINGS

For more information

- For more information on the webcasts, including link video archives of the webcasts and handouts, please go to

http://www.energycodes.gov/federal/webcast_federal_series.stm

DOE's Federal Energy Management Program (FEMP)

- As the largest energy consumer in the United States, the federal government has both a tremendous opportunity and a clear responsibility to lead by example with smart energy management.
- By promoting energy efficiency and the use of renewable energy resources at federal sites, the Federal Energy Management Program helps agencies save energy, save taxpayer dollars, and demonstrate leadership with responsible, cleaner energy choices.

FEMP Services

- FEMP offers a wide variety of technical assistance to agencies in the areas of
  - equipment procurement
  - new construction/retrofits
  - operations and maintenance
  - utility management.
- See http://www1.eere.energy.gov/femp/ for more information

Thank You for Participating

Questions for Presenters?