ASU Health Services Expansion and Renovations

Tempe, Arizona

LEED-NC v3

Energy Analysis Report

Provided by



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I. Introduction

Design is underway for the expansion and renovation of the ASU Health services building in Tempe, Arizona. This two story health clinic will consist of exam areas and administration areas. The project is seeking certification under the United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED version 3) program. This document is provided in support of these guidelines, specifically with respect to Energy and Atmosphere Prerequisite 2 (EAp2), Minimum Energy Performance, and Energy and Atmosphere Credit 1 (EAc1), Optimize Energy Performance.

The purpose of this preliminary report is to assess the current building design and gauge the annual energy performance in comparison with ASHRAE 2007. The intent is that the results from this preliminary study will help guide design decisions for the envelope, lighting, and mechanical systems in the building.

II. **Background**

Leadership in Energy & Environmental Design (LEED) is an internationally recognized green building certification system, providing third-party verification that a building was designed and built using strategies intended to improve performance in metrics such as energy savings, water efficiency, CO2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.

Developed by the U.S. Green Building Council (USGBC), LEED is intended to provide building owners and operators a concise framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.

Points are distributed across major credit categories such as Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. Prerequisites in each category receive no points and are mandatory for all projects.¹

III. **Methodology**

Under LEED guidelines, there are two approaches to calculating a building's energy score, Prescriptive and Energy Performance:

The Prescriptive Compliance Path requires that individual building components (envelope, lighting, and HVAC systems), exceed the minimum requirements prescribed by either the ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004 (1 point) or the Advanced Buildings™ Core Performance™ Guide (1-3 points), depending on the building type, size, usage, etc...

¹ Source: http://en.wikipedia.org/wiki/Leadership in Energy and Environmental Design





The Energy Performance Path (Whole Building Energy Simulation) requires an improvement in energy usage be demonstrated with an energy model of the building that follows the Building Performance Rating Method found in Appendix G of ASHRAE 90.1-2007.

Using the Energy Performance Path, an hourly building simulation model was developed using the eQUEST (DOE2.2) computer software. The features of the baseline building model are minimally compliant with ASHRAE 90.1-2007 Appendix G. Improvements to this model are then made to reflect design improvements to the building's envelope, lighting, and HVAC systems that have been incorporated into the as-proposed building. The energy cost savings between the ASHRAE 90.1 benchmark building and the as-designed building are then used to determine the number of Energy Optimization Credits. Long term hourly weather data (TMY 3) was used for the analysis.

IV. **Building Description**

The ASU Health Services building is a two-story facility consisting primarily of exam rooms and administration areas. The project totals approximately 34,300 sqft.

Figure 1 below shows the 3D schematic of the model, while the zoning/floorplan can be seen in Figure 2. Additional building information is found in the following sections.



Figure 1 – 3D representation *eQUEST* model

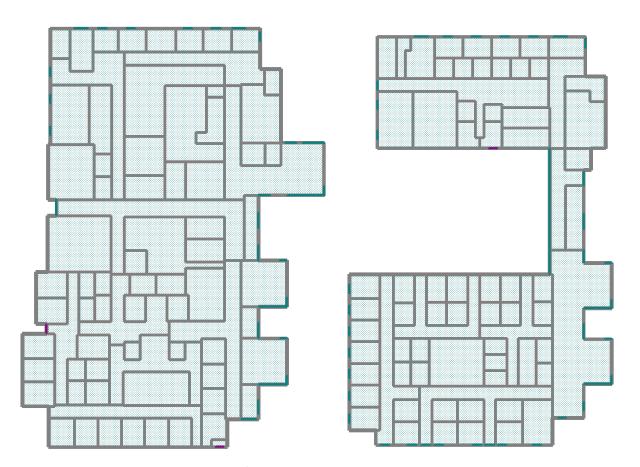


Figure 2 – 1st Floor zoning/floorplan of *eQUEST* model

Operation A.

This building is operated on a year round basis, 7am to 6pm Monday through Friday, except federal holidays.

B. **Envelope**

The building is located in Tempe, Arizona, which is in ASHRAE Climate Zone 2B. The ASHRAE climate zone dictates which envelope table is used, and subsequently the minimum insulation required. A summary of all the envelope components of the Proposed and Baseline buildings is provided below:

1. **Exterior Walls**

Baseline

The baseline Appendix G construction is a steel-framed exterior wall with R-13 batt insulation (U-0.124 Btu/h-ft²-°F).

Proposed

The proposed exterior wall construction utilizes 1.5" rigid insulation on steel studs 16" on center with R-19 batt insulation, and finished with gyp board (U-value 0.074). On existing areas of the building the walls will be block furred out with R-13 batt insulation (U-value 0.115).

2. Roofs

Baseline

The baseline Appendix G LEED Construction is built-up roof with R-20 continuous insulation above deck (U-0.048 Btu/h-ft²-°F).

Proposed

The proposed roof construction utilizes a build up roof with R-30 insulation (U-0.037 Btu/h-ft²-°F).

3. **Glass**

Baseline

The baseline Appendix G LEED glazing has an assembly U-value of 0.75 and a SHGC of 0.25.

Proposed

A high performance Low-E glass is utilized in the proposed glazing system. This glazing has center of glass (CoG) U-value of 0.29 and a solar heat gain coefficient (SHGC) of 0.31. The overall window-to-wall ratio for the building is approximately 18%. Frames were modeled explicitly in eQUEST.

C. Interior Lighting

Baseline

The ASHRAE 90.-2007 lighting budget was determined using the "Space-by-Space" method which assigns a maximum allowable lighting power density (LPD) based on the space type or function. The overall baseline LPD is 1.12 W/sqft.

Proposed

The proposed lighting design utilizes high efficiency T-8 fixtures in an optimized layout, yielding an overall building LPD of 0.88 W/sqft (a 21% improvement over ASHRAE 90.1-2007).

The proposed lighting design also includes occupancy sensors. For these sensors, a ten percent lighting power credit is allowed by Appendix G and applied to all lighting connected to occupancy sensors. Occupancy sensors are required in all conference rooms and must be modeled with occupancy sensors in both the baseline and as design models.

Figure below shows the comparison of the Baseline and Proposed lighting power densities.

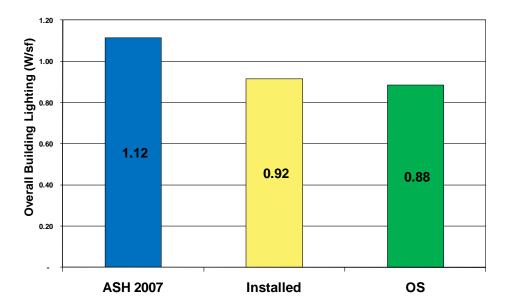


Figure 3 – Baseline vs. Proposed lighting power density

Exterior Lighting D.

This project can take credit for efficient exterior lighting within ASHRAE 90.1 Appendix G. Credit is only taken for the tradable surfaces listed in ASHRAE 90.1-2007 Table 9.4.5. All other exterior lighting is modeled identically in the Baseline and Proposed case. The Baseline case exterior lighting power allowance is calculated using the methodology outline in Section 9.4.5.

	Baseliı	ne	Propos	sed
Tradable	7,999	W	2,856	W
Non-Tradable	0	W	0	W
Total	7,999	W	2,856	W

E. **HVAC**

Baseline

The ASHRAE 90.1 Appendix G Baseline system for the building is packaged variable air volume with hot water reheat. The PVAV units are auto sized in the baseline with efficiencies and fan powers from ASHRAE 90.1 Appendix G.

Proposed

The Proposed mechanical design includes new rooftop VAV unit with electric reheat to provide space heating and cooling for new section of the building. Heating for the existing building and cooling for both new and existing areas are supplied by ASU's district plant. The existing multizone air handler will be converted to a VAV system with temperature control from the existing hot deck and cold deck for each zone. The existing air handler will keep the existing steam coil in place for the hot deck. Per LEED requirements, the overall plant was modeled with an overall COP of 4.4 and the heating was modeled with an overall efficiency of 70%. Demand Control Ventilation is not utilized. No credit can be taken for DCV. See the HVAC Summary Table below for further details.

				Ва	seline							Pro	posed			
	Total	Cooling /							Total	Cooling /						
	Supply	Heating	Fan		Cooling	Heating	Cooling	Heating	Supply	Heating	Fan		Cooling	Heating	Cooling	Heating
	Flow	Sizing	Power	Total	Capacity	Capacity	Efficiency	Efficiency	Flow	Sizing	Power	Total	Capacity	Capacity	Efficiency	Efficiency
Unit	(cfm)	Ratio	(W/cfm)	Fan kW	(kBtu/hr)	(kBtu/hr)	(EER)	(COP)	(cfm)	Ratio	(W/cfm)	Fan kW	(kBtu/hr)	(kBtu/hr)	(EER)	(COP)
RTU-1	20,297	1.15 / 1.25	1.217	24.70	658.6	-390.3	9.8	(Boiler)	30,000	1.0 / 1.0	1.067	32.01	962.2	-290.2	(Chiller)	(Boiler)
RTU-2	15,912	1.15 / 1.25	1.225	19.49	527.9	-338.2	9.8	(Boiler)	21,360	1.0 / 1.0	0.850	18.16	484.0	-137.4	(Chiller)	(Boiler)
AC-1	338	1.15 / 1.25	1.166	0.39	9.0	0.5	SEER 13	80%	425	1.0 / 1.0	0.198	0.08	12.0	0.5	SEER 15.2	(Boiler)
AC-2	375	1.15 / 1.25	0.923	0.35	9.7	0.5	SEER 13	80%	425	1.0 / 1.0	0.198	0.08	12.0	0.5	SEER 15.2	(Boiler)
AC-3	692	1.15 / 1.25	0.909	0.63	18.5	0.5	SEER 13	80%	920	1.0 / 1.0	0.182	0.17	34.2	0.5	SEER 14	(Boiler)
DFC-1	826	1.15 / 1.25	0.849	0.70	20.9	0.5	SEER 13	80%	900	1.0 / 1.0	0.181	0.16	26.8	0.5	(Chiller)	(Boiler)
Total	38,440			46	1,245	-727			54,030			51	1,531	-426		

*Per Appendix G *Per DWGs

Renewable Energy Sources F.

A 69.3 kW system has been proposed for this project. This system is estimated to produce 103,229 kWh annually.

G. **Utility Rates**

State average utility rates from DOE's Energy Information Administration (EIA) were used in the analysis. A summary of the utility rates can be seen below.

EIA Average Electric Commercial Rate (Arizona, Nov. 2011):

Average Energy Charge: \$0.08860 per kWh

EIA Average Natural Gas Commercial Rate (Arizona, Nov. 2011):

\$0.92500 per therm Average Energy Charge:

V. Modeling Summary

A total of five simulations were done beginning with the minimum ASHRAE 90.1-2007 baseline model (blue background). Each run was done incrementally incorporating the features of the previous run. The final run (green background) represents the as-designed building. Note that the intermediate runs are provided for information purposes to assess the relative impact of each building system. LEED credit calculations are done only between the ASHRAE base and the final HVAC run.

The inputs and assumptions of the simulation order described below can be found in Table 2:

ASHRAE: Minimum ASHRAE 90.1-2007 model

E-1: ASHRAE 90.1 plus Envelope

L-1: E-1 plus Lighting
M-1: L-1 plus Mechanical
R-1: M-1 plus PV System

		ASI	HRAE Baseline	vs. Proposed	Design		
			B-0*	E-1	L-1	M-1	R-1
			ASHRAE 90.1 2007 CZ 2B	Envelope	Lighting	Mechanical	PV System
	5 (U-Value / R-Value	0.048 / 20ci	0.037 / 30	0.037 / 30	0.037 / 30	0.037 / 30
	Roof	Framing	Above Deck	Above Deck	Above Deck	Above Deck	Above Deck
	NI	U-Value / R-Value	0.124 / 13	0.074 / 19+5ci	0.074 / 19+5ci	0.074 / 19+5ci	0.074 / 19+5ci
e e	New Walls	Framing	Steel Stud	Steel Stud	Steel Stud	Steel Stud	Steel Stud
log	Eviciting Wolls	U-Value / R-Value	0.124 / 13	0.115 / 13	0.115 / 13	0.115 / 13	0.115 / 13
Envelope	Exisiting Walls	Framing	Steel Stud	Steel Stud	Steel Stud	Steel Stud	Steel Stud
늅		U-Value	0.57	0.29	0.29	0.29	0.29
	Windows	SHGC / SC	0.25 / 0.29	0.31/0.36	0.31/0.36	0.31/0.36	0.31/0.36
		Frames	n/a	Yes	Yes	Yes	Yes
	Shading	Exterior (Fixed)	No	Yes	Yes	Yes	Yes
90	Overall LPD	Watts / sqft	1.12	1.12	0.88	0.88	0.88
Lighting	Controls	Occupancy	n/a	n/a	Yes	Yes	Yes
gh	F	Tradable KW	7.99	7.99	2.86	2.86	2.86
=	Exterior	Non Tradable kW	0	0	0	0	0
		System Type	Package VAV w/ Electric Reheat	Package VAV w/ Electric Reheat	Package VAV w/ Electric Reheat	VAV w/ Electric Reheat	VAV w/ Electric Reheat
	New AHU	Fan Control	VFD	VFD	VFD	VFD	VFD
em		OA Economizer	Yes	Yes	Yes	Yes	Yes
yst		Fan Power	1.217 W/CFM	1.217 W/CFM	1.217 W/CFM	1.067 W/CFM	1.067 W/CFM
ė Š		EER	10 EER	10 EER	10 EER	(Chiller)	(Chiller)
Airside System		System Type	Package VAV w/ HW Reheat	Package VAV w/ HW Reheat	Package VAV w/ HW Reheat	VAV w/ HW Reheat	VAV w/ HW Reheat
٨		Fan Control	VFD	VFD	VFD	VFD	VFD
	Existing AHU	OA Economizer	Yes	Yes	Yes	Yes	Yes
		Fan Power	1.225 W/CFM	1.225 W/CFM	1.225 W/CFM	0.856 W/CFM	0.856 W/CFM
		EER	9.8 EER	9.8 EER	9.8 EER	(Chiller)	(Chiller)
		Compressor Type	n/a	n/a	n/a	(District)	(District)
		Condensor	n/a	n/a	n/a	(District)	(District)
Bu	Chillers /	СОР	n/a	n/a	n/a	4.40	4.40
Cooling	Chilled Water	CHW ST (deg F)	n/a	n/a	n/a	44	44
ပ္ပ	System	CHW ΔT (deg F)	n/a	n/a	n/a	12	12
	·	Pump Motor Class	n/a	n/a	n/a	High Efficiency	High Efficiency
	ľ	Pump Drive Type	n/a	n/a	n/a	VFD	VFD
		No. of Boilers	2	2	2	(District)	(District)
20		Efficiency (%)	80%	80%	80%	70%	70%
ij	Boilers / Hot	HW ST (deg F)	180	180	180	180	180
Ť	Water System	HW ΔT (deg F)	50	50	50	40	40
Heating		Pump Motor Class	High Efficiency	High Efficiency	High Efficiency	High Efficiency	High Efficiency
Renewables	Dhoto: -!t-!:	kW	n/a	n/a	n/a	n/a	69
ЭΕΝ	Photovoltaic	Annual kWh	n/a	n/a	n/a	n/a	103,229
Rer		Fixed/Tracking	n/a	n/a	n/a	n/a	Fixed

^{*} Average of four runs (building rotated 90 deg each run)

Table 2 – Modeling Summary Table



VI. Analysis Results

Results of the analysis are summarized in the Table below. The building has the potential to achieve approximately \$19,594 (48.9%) in annual utility savings per year compared to a minimally compliant ASHRAE 90.1-2007 building. More detailed results are shown in the Table and Figure below.

	Description		Tota	al		Electric			Cos	t		LE	ED
		Elec	Electric	Gas	Lighting	HVAC	Equip	Electric	Gas	Total	Total	LEED	EAc1
#	Name	kW	kWh	Therms	kWh	kWh	kWh	\$	\$	\$	\$/sqft	%	Points
B-0	ASHRAE 90.1-2007	202	433,128	1,825	99,652	190,355	108,209	\$38,375	\$1,688	\$40,063	\$1.16		0
E-1	0+Envelope	189	418,170	1,482	99,652	175,397	108,209	\$37,050	\$1,371	\$38,421	\$1.12	4.1%	0
L-1	E-1+Lighting	177	365,528	1,599	77,242	167,598	108,209	\$32,386	\$1,479	\$33,865	\$0.98	15.5%	2
M-1	L-1+Mechanical	129	321,684	1,205	77,242	123,753	108,209	\$28,501	\$1,114	\$29,615	\$0.86	26.1%	8
R-1	M-1+PV System	129	218,455	1,205	77,242	123,753	108,209	\$19,355	\$1,114	\$20,469	\$0.60	48.9%	19

Table 3 – Estimated Annual Utility and Energy Costs

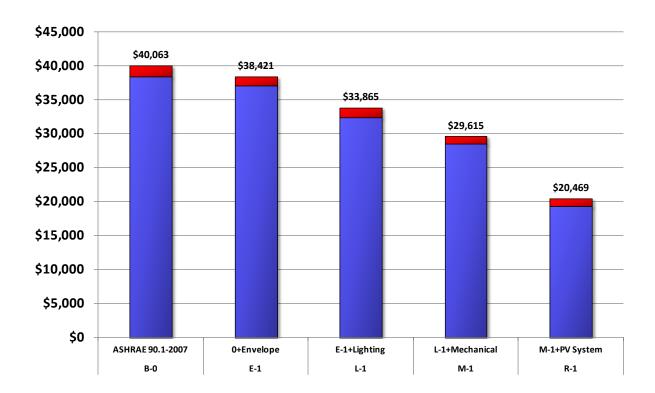


Figure 4 – Estimated Annual Utility Costs

VII. LEED Calculations

From a LEED perspective, the building is 48.9% below ASHRAE and is eligible for 19 points according to Option 1 under EA Credit 1. The renewable energy generated by the PV System accounts for 30.9% of the overall energy usage and is eligible for 7 points under EA Credit 2. Calculations are provided in this section in the format prescribed by the USGBC.

Energy & Cost Summary

Energy & Cost Summa	- ,		Base	line (ECB')		Prop	oosed (DE	C'')
		Electric	Gas	Energy Use	Energy Cost	Electric	Gas	Energy Use
End-Use	Energy Type	kWh	Therms	kBtu/sf/yr	%	kWh	Therms	kBtu/sf/yr
Lighting	Electric	99,652	-	9.9	22%	77,242	-	7.7
Misc Equipment	Electric	108,209	-	10.7	24%	108,209	-	10.7
Space Heating	Electric/Gas	-	776	2.3	2%	4,544	156	0.9
Space Cooling	Electric	135,161	-	13.4	30%	83,434	-	8.3
Fans	Electric	54,364	-	5.4	12%	31,494	-	3.1
Pumps/Aux	Electric	830	-	0.1	0%	4,281	-	0.4
Exterior	Electric/Gas	34,912	-	3.5	8%	12,479	-	1.2
Domestic Hot Water	Electric/Gas	ı	1,049	3.0	2%	-	1,048	3.0
Subtotal Regulated		433,128	1,825	48.3	100%	321,683	1,204	35.4
Regulated Cost	\$	\$38,375	\$1,688	\$40,063		\$28,501	\$1,114	\$29,615
	·			_				
Total Building	Energy	433,128	1,825	48.3		321,683	1,204	35.4
	Cost	\$38,375	\$1,688	\$1.16		\$28,501	\$1,114	\$0.86

Annual Energy & Utility Cost						
	Base	line	Prop	osed	Savi	ngs
Energy Type	kBtu/sqft	Cost \$	kBtu/sqft	Cost \$	Energy%	Cost%
Electricity Natural Gas	43.0 5.3	\$38,375 \$1,688	31.9 3.5	\$28,501 \$1,114	25.7% 34.0%	25.7% 34.0%
Subtotal	48.3	\$40,063	35.4	\$29,615	26.6%	26.1%
Renewable Photovoltaics	0	\$0	10.2	\$9,146	28.9%	30.9%
Solar Hot Water	0	\$0	0.00	\$0	0.0%	0.0%
Exceptional Calculation	0	\$0	0.0	\$0	0.0%	0.0%
Total	48.3	\$40,063	25.2	20,469	47.9%	48.9%
		Ene	rgy Optimiz	ation EAc1	% 48.9%	Credits 19
		R	enewable Eı	nergy EAc2	30.9%	7
			EA	Credit 1 &	2 Points =	26

Table 4 – LEED Calculations

VIII. Appendices

Envelope Requirements A.

TABLE 5.5-2 Building Envelope Requirements for Climate Zone 2 (A, B)*

	Non	residential	Re	sidential	Se	miheated
Opaque Elements	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.218	R-3.8 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.167	R-6.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.081	R-13.0
Walls, Above-Grade						
Mass	U-0.151a	R-5.7 c.i.a	U-0.123	R-7.6 c.i.	U-0.580	NR
Metal Building	U-0.113	R-13.0	U-0.113	R-13.0	U-0.184	R-6.0
Steel-Framed	U-0.124	R-13.0	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel-Joist	U-0.052	R-19.0	U-0.052	R-19.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.051	R-19.0	U-0.033	R-30.0	U-0.066	R-13.0
Slab-On-Grade Floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.450		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
Vertical Glazing, 0%-40% of Wall						
Nonmetal framing (all) ^b	U-0.75		U-0.75		U-1.20	
Metal framing (curtainwall/storefront) ^c	U-0.70	SHGC-0.25 all	U-0.70	SHGC-0.25 all	U-1.20	SHGC-NR all
Metal framing (entrance door)c	U-1.10		U-1.10		U-1.20	
Metal framing (all other) ^c	U-0.75		U-0.75		U-1.20	
Skylight with Curb, Glass, % of Roof						
0%-2.0%	$^{\mathrm{U}}\mathrm{all}^{-1.98}$	$^{\mathrm{sHGC}}$ all $^{-0.36}$	$U_{\mathrm{all}^{-1.98}}$	succall_0.19	$v_{\rm all^{-1.98}}$	SHGC _{all} -NR
2.1%-5.0%	$^{ m U}{ m all}^{-1.98}$	shgc _{all} -0.19	$U_{\mathrm{all}^{-1.98}}$	succall_0.19	$^{\mathrm{U}}\mathrm{all}^{-1.98}$	SHGC _{all} -NR
Skylight with Curb, Plastic, % of Roof						
0%-2.0%	$\mathrm{u_{all}^{-1.90}}$	$^{\mathrm{shgc}}\mathrm{all}^{-0.39}$	$v_{\rm all}$ –1.90	sugcall_0.27	$v_{\rm all^{-1.90}}$	shgc _{all} -NR
2.1%-5.0%	$^{ m U}{ m all}^{-1.90}$	shgc _{all} -0.34	^U all ^{-1.90}	sugcall_0.27	$v_{\rm all}$ -1.90	SHGC _{all} -NR
Skylight without Curb, All, % of Roof						
0%-2.0%	$^{\mathrm{U}}\mathrm{all}^{-1.36}$	shgc _{all} -0.36	$U_{\mathrm{all}^{-1.36}}$	succall_0.19	$v_{\rm all^{-1.36}}$	shgc _{all} -NR
2.1%-5.0%	^U all ^{-1.36}	shgc _{all} -0.19	Uall-1.36	sHGCall-0.19	Uall-1.36	SHGC _{all} -NR

^{*}The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

*Exception to Section A3.1.3.1 applies.

*Normetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

*Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Lighting Calculations B.

			Lighting	Lighting	Power De	nsity	Fixture																					—
Space Name	Space Type	Area	Controls	ASH 20		OS	Name	Α	В	С	D	Е	F	G	н	J	J1	ĸ	L	м	N	Р	Q	R	s	т	v	
opace Hame	Opace Type	(sqft)	OS	W/sf	W/sf	W/sf	Watts	86					26								_	28				59		
4 - 4 - 51		(Sqit)		WV/SI	VV/51	VV/51	walls	00	32	59	59	40	20	200	42	42	52	59	32	32	32	20	32	42	42	39	59	
1st Floor	la		(Y/N)	•			1				1									1								
Nurses Office 1 1F	Office	150		1.10	0.58	0.58	86	1																		\vdash		
Exam 9 1F	Hospital	140		1.50	0.62	0.62	86	1																		\longrightarrow	_	
Exam 8 1F	Hospital	137		1.50	0.63	0.63	86	1																		-	_	
Exam 7 1F	Hospital	137		1.50	0.63	0.63	86	1																			_	
Exam 6 1F	Hospital	140		1.50	0.62	0.62	86	1																			_	
Exam 5 1F	Hospital	137		1.50	0.63	0.63	86	1																			_	
Mechanical 1 1F	Mechanical	23		1.50	5.18	5.18	118				2																	
Exam 4 1F	Hospital	148		1.50	0.58	0.58	86	1																				
Exam 3 1F	Hospital	121		1.50	0.71	0.71	86	1																				
Exam 2 1F	Hospital	118		1.50	0.73	0.73	86	1																				
Exam 1 1F	Hospital	121		1.50	0.71	0.71	86	1																				
FT Nurse 1 1F	Hospital	450		1.50	1.66	1.66	748	2				12																
Restroom 1 1F	Restroom	56		0.90	0.57	0.57	32														1							
Office 1 1F	Office	162		1.10	0.53	0.53	86	1																				
Office 2 1F	Office	155		1.10	0.56	0.56	86	1																		ш		
Office 3 1F	Office	162		1.10	0.89	0.89	145	1			1																	
Sports Exam 1 1F	Hospital	165		1.50	0.52	0.52	86	1																				
Sports Exam 2 1F	Hospital	161		1.50	0.53	0.53	86	1																				
Imaging 1 1F	Hospital	726		1.50	0.87	0.87	632	4				1	8								1							
Central Stores 1 1F	Hospital	514		1.50	0.46	0.46	236			4																		
Conference 1 1F	Conference	464	Υ	1.30	0.93	0.83	430	5																				
Stairs 1 1F	Stairs	118		0.60	0.00	0.00	0																					
Office 4 1F	Office	202	Υ	1.10	0.43	0.38	86	1																				
Office 5 1F	Office	118	Υ	1.10	1.46	1.31	172	2																				
Office 6 1F	Office	134	Υ	1.10	1.28	1.16	172	2																				
Office 7 1F	Office	139	Υ	1.10	0.62	0.56	86	1																				
Office 8 1F	Office	131	Υ	1.10	1.31	1.18	172	2																				
Office 9 1F	Office	134	Υ	1.10	1.28	1.16	172	2																				
Office 10 1F	Office	137	Υ	1.10	1.41	1.27	192					4																
Stairs 2 1F	Stairs	83		0.60	0.00	0.00	0																					
Admin Wait 1 1F	Waiting	435		0.80	0.00	0.00	0																					
Storage 2 1F	Storage-Active	72		0.80	0.82	0.82	59				1																	
Stairs 3 1F	Stairs	190		0.60	0.00	0.00	0																					
Public Wait 1 1F	Waiting	431		0.80	0.53	0.53	227																		4	1		
Public Wait 2 1F	Waiting	431		0.80	0.53	0.53	227																		4	1		
Public Wait 3 1F	Waiting	114		0.80	0.52	0.52	59											1								П		
Public Wait 4 1F	Waiting	124		0.80	0.48	0.48	59											1								ıT		
Reception 1 1F	Waiting	401		0.80	1.14	1.14	456	2			2		1									5				ıT		
FT Exam 3 1F	Hospital	123	Υ	1.50	0.70	0.63	86	1																		ıT		
FT Exam 4 1F	Hospital	115	Υ	1.50	0.75	0.68	86	1																		ıT		
Lab 1 1F	Lab	653	Υ	1.40	0.71	0.64	462	5													1					ıT		
Restroom 2 1F	Restroom	179	Υ	0.90	2.32	2.09	416					4								7						Π		\neg
Restroom 3 1F	Restroom	175	Y	0.90	2.29	2.06	400					3								8						一	\Box	\neg

FT Exam 2 1F	Hospital	111	Υ	1.50	0.77	0.70	86	1		l				-									\neg	\neg	\neg
Blood Draw 1 1F	Hospital	110	Y	1.50	0.77	0.70	86	1							-								\dashv	+	一
FT Exam 1 1F	Hospital	117	Y	1.50	0.78	0.76	86	1							-								-	-+	\dashv
Restroom 4 1F	Restroom	56	Y	0.90	1.05	0.00	59		1						-								-	-+	\dashv
Clean Utility 1 1F	Laundry	89	Y	0.60	0.36	0.32	32								-				1				-	-+	\dashv
Exam 10 1F	Hospital	118	Y	1.50	0.30	0.65	86	1							-				 				-	-+	\dashv
Exam 11 1F	Hospital	107	Y	1.50	0.73	0.03	86	1							-								-	-+	\dashv
Soiled Utility 1 1F	Laundry	80	Y	0.60	0.80	0.72	59		1						-								-	-+	\dashv
Exam 12 1F	Hospital	159	Y	1.50	1.08	0.00	172	2							-								-	-+	\dashv
EQ St 1 1F	Hospital	83	Y	1.50	1.03	0.98	86	1							-								-	-+	\dashv
Cast St 1 1F	Hospital	78	Y	1.50	0.33	0.30	26					1			-								-	-+	\dashv
Consult 1 1F	Office	90	Y	1.10	0.33	0.86	86	1							-								-	-+	\dashv
Consult Wait 1 1F	Waiting	77	ı	0.80	1.09	1.09	84					2			-		1		-				\rightarrow	+	\dashv
Consult Wait 2 1F	Waiting	82		0.80	1.66	1.66	136					4		-			1						\dashv	+	\dashv
Storage 3 1F	Storage-Active	82		0.80	1.35	1.35	111		1			2		-									\dashv	+	\dashv
								4			H		_	_	-				-				\rightarrow	+	\dashv
Staff Locker 1 1F Electrical 1 1F	Locker	306		0.80	1.23	1.23	376	4		_	H	_	_	_	-				1				\rightarrow	+	\dashv
	Electrical	199		1.50	0.85	0.85	170	<u> </u>		2	\vdash	2			\dashv	-			\vdash			\vdash	\dashv	\dashv	\dashv
Staff Lounge 1 1F	Lounge	324	Y	1.20	1.06	1.06	344 994	11			1				_				_	1		\vdash	\rightarrow	\dashv	\dashv
Billing 1 1F	Office	839	Y	1.10	1.18	1.07		11		_	1								_				\rightarrow	\rightarrow	\dashv
Electrical 2 1F	Electrical	157		1.50	0.75	0.75	118			2	\vdash			_	-				_				\rightarrow	\rightarrow	-
Mechanical 2 1F	Mechanical	298		1.50	0.40	0.40	118	_		2	\vdash	_	_	_	-				<u> </u>	-			\rightarrow	+	\dashv
Pharmacy 1 1F	Office	681		1.10	1.29	1.29	878	9				4			_									_	4
IDF 1 1F	Electrical	40		1.50	1.48	1.48	59			1					_						_			_	4
Pharmacy 2 1F	Office	189		1.10	0.65	0.65	122				\sqcup	1			_				_		3		_	\rightarrow	_
Corridor 1 1F	Corridor	739		1.00	2.08	2.08	1,538	1			\sqcup	2	7		_				_				_	\rightarrow	_
Corridor 2 1F	Corridor	643		1.00	0.94	0.94	602	7			\sqcup				_				_				_	\rightarrow	_
Corridor 3 1F	Corridor	462		1.00	1.04	1.04	478	5			1				_				_				_	\rightarrow	_
Corridor 4 1F	Corridor	413		1.00	0.83	0.83	344	4			\sqcup				_				_				_	\rightarrow	_
Corridor 5 1F	Corridor	557		1.00	0.87	0.87	482	5				2												_	긕
Corridor 6 1F	Corridor	968		1.00	1.08	1.08	1,050	7										14						_	_
Corridor 7 1F	Corridor	663		1.00	0.78	0.78	516	6																_	_
Corridor 8 1F	Corridor	529		1.00	0.67	0.67	354	3			2													_	_
Corridor 9 1F	Corridor	1,082		1.00	1.11	1.11	1,198				5			1				4			1	18		_	_
Nurses Office 1 2F	Office	284	Y	1.10	0.61	0.55	172	2																	_
WEX 2 2F	Hospital	134	Υ	1.50	0.64	0.58	86	1																	_
WEX 1 2F	Hospital	128	Υ	1.50	0.67	0.60	86	1																_	_
WEX 4 2F	Hospital	129	Υ	1.50	0.67	0.60	86	1																_	_
WEX 3 2F	Hospital	123	Υ	1.50	0.70	0.63	86	1																_	_
WEX 6 2F	Hospital	126	Υ	1.50	0.68	0.61	86	1																_	_
WEX 5 2F	Hospital	120	Υ	1.50	0.71	0.64	86	1																	
WEX 8 2F	Hospital	129	Υ	1.50	1.33	1.20	172	2																	
WEX 7 2F	Hospital	123	Υ	1.50	1.40	1.26	172	2																	
W Office 1 2F	Office	148	Υ	1.10	1.16	1.05	172	2											$oxed{oxed}$					\bot	
W Office 2 2F	Office	138	Υ	1.10	0.63	0.56	86	1											$oxed{oxed}$					\bot	
W Office 3 2F	Office	138	Υ	1.10	1.25	1.13	172	2																	$oldsymbol{ol{ol{ol}}}}}}}}}}}}}}}}}$
P Office 1 2F	Office	138	Υ	1.10	0.63	0.56	86	1			$oxed{\Box}$														
P Office 2 2F	Office	138	Υ	1.10	1.25	1.13	172	2																	
P Office 3 2F	Office	138	Υ	1.10	0.63	0.56	86	1																	
NRS Office 1 2F	Office	151	Υ	1.10	0.57	0.51	86	1																	
PEX 12 2F	Hospital	127	Υ	1.50	0.68	0.61	86	1																	

Subtotal		33,692		1.12	0.92	0.88	30,861	209	0		14		39	14	1 (0		3	_	7	13	4	3 3	38 4	_	0
									l		1					1	1	1	1		1 1					
Corridor 7 2F	Corridor	790		1.00	0.90	0.90	709	7			1	1				\bot					igspace	\dashv			-	\bot
Corridor 6 2F	Corridor	381		1.00	0.74	0.74	282				Ш	5		_	\perp	\bot		igwdown			$\sqcup \!\!\! \perp$	\dashv	_	1	1	\bot
Corridor 5 2F	Corridor	396		1.00	0.96	0.96	380				Ш	2		1	\bot	\perp		Ш			$\vdash \vdash$	\dashv	_	2	+	+
Corridor 4 2F	Corridor	482		1.00	0.71	0.71	344	4			Ш			_		_		Ш			$\vdash \vdash$	\dashv	_	\perp	+	+
Corridor 3 2F	Corridor	444		1.00	0.97	0.97	430	5		\vdash	Ш			_	\perp	+		Ш			$\vdash \vdash$	\dashv	_	\perp	+	+
Corridor 2 2F	Corridor	589		1.00	0.73	0.73	430	5			Ш			-	_	-						\dashv	_	_	-	+
Corridor 1 2F	Corridor	574		1.00	0.90	0.90	516	6	_		Ш			_	_	+			\vdash		$\vdash \vdash$	\dashv	_	_	+	+
Naiting 2 2F	Waiting	1,644		0.80	1.08	1.08	1,772	_		\vdash	Н			6	+	+	2	\vdash	\vdash		$\vdash \vdash$	+	+	3 2	+	+
Open Area 1 2F	Office	451		1.10	0.28	0.28	126	_		\vdash	Н			\perp	+	+	<u> </u>	\vdash	\vdash		$\vdash \vdash$	+	3	+	+	+
Mech 1 2F	Mechanical	520		1.50	0.00	0.00	0	_			Ш			-	\perp	+			\vdash		$\vdash \vdash$	\dashv	_	+	+	+
Chiro 2 2F	Office	78	Y	1.10	0.75	0.68	59	_		1	Н			-	-	_		H	\vdash		\vdash	\dashv	-	+	-	+
Chiro 1 2F	Office	111	Y	1.10	0.78	0.70	86	1		.	Н			-	-	-					\vdash	\dashv	-	-		+
Clean Storage 1 2F	Storage-Active	66	Y	0.80	0.89	0.80	59		\vdash	1	Н		-	+	+	+		$\vdash\vdash$			\vdash	+	+	+	+	+
Soiled Storage 1 2F	Storage-Active	111		0.80	0.78	0.70	86	1		\vdash	H			+	+	+-	<u> </u>				\vdash	+	+	+		+
			Y					-	\vdash	\vdash	H	4		+	+	+			Э		\vdash	+	+	+	+	+
Restroom 4 2F	Restroom	201	Y	0.90	2.47	2.22	496	\vdash			Н	4	-	+	+	+-		\vdash	9		\vdash	+	+	+	-	+
Restroom 4 2F	Restroom	201	Y	0.80	2.47	2.22	496	- -			Н	5		\dashv	+	+	1	\vdash	8		\vdash	+	\dashv	+	+	+
Storage 4 2F	Storage-Active	81	ı	0.80	1.03	1.06	86	1			H			\dashv	+	+	1					+	\dashv	+	+	+
Acu Prep 2 2F	Office	83	Y	1.10	1.03	0.93	86	1			Н			-	_	+						+	\dashv	+		+
Acupuncture 2 2F	Office	127	Y	1.10	0.68	0.93	86	1		H	H			-	+	+			Н			\dashv	\dashv	+	+	+
Acu Prep 1 2F	Office	83	Y	1.10	1.03	0.93	86	1		Н	H			-	+	+			Н			\dashv	\dashv	+	+	+
Acupuncture 1 2F	Office	127	Y	1.10	0.68	0.61	86	1		Н	H			-	+	+						\dashv	\dashv	+	+	十
Massage Prep 2 2F	Office	81	Y	1.10	1.06	0.96	86	1			Н		-+	\dashv	+	+		\vdash			\vdash	+	\dashv	+	+	+
Massage 2 2F	Office	127	Y	1.10	0.68	0.61	86	1		Н	H			\dashv	+	+						\dashv	\dashv	+	+	+
Storage 3 2F	Storage-Active	83		0.80	1.03	1.03	86	1			Н			+	_	+						+	\dashv	_		+
Massage Prep 1 2F	Office	83	Y	1.10	1.03	0.93	86	1			Н			\dashv	\top	\top		\Box				\dashv	\dashv	\top		\forall
Massage 1 2F	Office	127	Y	1.10	0.68	0.61	86	1		П	П			\neg	\top	\top						\dashv	\dashv	\top	+	†
Nutrition 1 2F	Office	239	Y	1.10	1.08	0.97	258	3		Ė	П			_	\top	\top						\dashv	\dashv	\top	+	†
Storage 2 2F	Storage-Active	93		0.80	1.57	1.57	145	1		1	П			\neg	\top	1						十	十	十	\top	寸
Stairs 1 2F	Stairs	168		0.60	0.51	0.51	86	1														\neg				丁
Conference 1 2F	Conference	423	Υ	1.30	0.98	0.88	414	3					6									\neg				丁
Waiting 1 2F	Waiting	163		0.80	0.55	0.55	90					1										▔		1		
Soiled Utility 1 2F	Laundry	90	Υ	0.60	0.66	0.59	59			1																
Clean Utility 1 2F	Laundry	86	Υ	0.60	1.00	0.90	86	1																		
Mech Chase 1 2F	Mechanical	89		1.50	0.67	0.67	59			1															I	I
Eq Storage 1 2F	Storage-Active	93		0.80	0.64	0.64	59			1																
Nurse Station 1 2F	Office	550		1.10	0.97	0.97	536	4				4														
Restroom 3 2F	Restroom	76	Υ	0.90	0.76	0.69	58						1							1		\Box				
Restroom 1 2F	Restroom	76	Υ	0.90	0.76	0.69	58						1							1		$\perp \!\!\! \perp$		┸		\perp
Reception 2 2F	Office	81		1.10	3.65	3.65	294	1				2									4	$\perp \!\!\! \perp$		┸		\perp
Support 1 2F	Office	176		1.10	0.97	0.97	170	1					2					1					_			丄
Reception 1 2F	Office	84		1.10	3.48	3.48	294	1				2									4	\bot				
PEX 1 2F	Hospital	99	Y	1.50	0.87	0.78	86	1														\bot				
PEX 2 2F	Hospital	113	Υ	1.50	0.76	0.69	86	1														\perp				
PEX 3 2F	Hospital	99	Υ	1.50	0.87	0.78	86	1														_				_
PEX 5 2F	Hospital	102	Y	1.50	0.84	0.76	86	1			Ш			_							lacksquare	ightharpoonup				\perp
PEX 4 2F	Hospital	118	Y	1.50	0.73	0.66	86	1														\dashv				_
PEX 6 2F	Hospital	121	Y	1.50	0.71	0.64	86	1														\dashv				_
PEX 8 2F	Hospital	124	Υ	1.50	0.69	0.62	86	1														\perp				
PEX 7 2F	Hospital	105	Y	1.50	0.82	0.74	86	1														\perp				
PEX 9 2F	Hospital	99	Υ	1.50	0.87	0.78	86	1														\perp				
PEX 10 2F	Hospital	118	Υ	1.50	0.73	0.66	86	1														\perp				
									_				_	_	_	_		_			_	-	_	_		\rightarrow

Output Summary Reports C.

1. **Baseline - BEPS**

REPORT-	BEPS Building	Energy Pe	erformance								E- Phoeni	x AZ	TMY2
	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELE MBTU	ECTRICITY J 340.1	0.0	369.3	0.0	460.6	0.0	2.8	184.9	0.0	0.0	0.0	119.2	1476.9
FM1 NAT	TURAL-GAS J 0.0 =====	0.0	0.0	74.2 ======	0.0	0.0	0.0	0.0	0.0	0.0	104.9	0.0	179.1
MBTU	340.1	0.0	369.3	74.2	460.6	0.0	2.8	184.9	0.0	0.0	104.9	119.2	1656.0
		TAL SITE E TAL SOURCE				48.2 KBT					QFT-YR NE QFT-YR NE		
	PE: HO	RCENT OF E RCENT OF E URS ANY ZO URS ANY ZO	ONE ABOVE	PLANT LOA	D NOT SAT	G RANGE	ITLING RA	= 0.	00				

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

2. Baseline - BEPU

REPORT- BEPU Building Utility Performance WEATHER FILE- Phoenix AZ TMY2									TMY2			
LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY KWH 99652.	0.	108209.	0.	134951.	0.	816.	54183.	0.	0.	0.	34912.	432723.
FM1 NATURAL-GAS THERM 0.	0.	0.	742.	0.	0.	0.	0.	0.	0.	1049.	0.	1791.

TOTAL ELECTRICITY 432723. KWH 12.587 KWH /SQFT-YR GROSS-AREA 12.587 KWH /SQFT-YR NET-AREA TOTAL NATURAL-GAS 1791. THERM 0.052 THERM /SQFT-YR GROSS-AREA 0.052 THERM /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.55
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 123
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 37

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

3. Baseline - ES-D

REPORT- ES-D Energy Cost Summa	ry 		WEATHER FII	AZ TMY2			
UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE (\$)	VIRTUAL RATE (\$/UNIT)	RATE USED ALL YEAR?	
Avg Elec Rate	ELECTRICITY	EM1	432723. KWH	38339.	0.0886	YES	
Avg Gas Rate	NATURAL-GAS	FM1	1791. THERM	1656.	0.9250	YES	
				======= 39996.			

ENERGY COST/GROSS BLDG AREA: 1.16 ENERGY COST/NET BLDG AREA: 1.16

Proposed - BEPS 4.

REPORT- BEPS		Energy Pe		:						ATHER FIL	E- Phoeni	.x AZ	TMY2
	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRI MBTU	CITY 263.6	0.0	369.3	15.5	284.8	0.0	14.6	107.5	0.0	0.0	0.0	42.6	1097.9
FM1 NATURAL MBTU	0.0	0.0	0.0	15.6 =====	0.0	0.0	0.0	0.0	0.0	0.0	104.8	0.0	120.5
MBTU	263.6	0.0	369.3	31.1	284.8	0.0	14.6	107.5	0.0	0.0	104.8	42.6	1218.4
		AL SITE E AL SOURCE		1218.35 3414.16		35.4 KBT 99.3 KBT	U/SQFT-YR U/SQFT-YR				GQFT-YR NE GQFT-YR NE		
	PER(HOU	CENT OF H RS ANY ZO	OURS ANY NE ABOVE	SYSTEM ZO PLANT LOA COOLING T HEATING T	D NOT SAT	RANGE	TTLING RA	NGE = 0. = 0. =	00				
	NOT	E: ENERG	Y IS APPO	RTIONED H	OURLY TO	ALL END-U	SE CATEGO	RIES.					

5. Proposed - BEPU

EM1 ELECTRICITY KWH 77242. 0. 108209. 4544. 83434. 0. 4281. 31494. 0. 0. 0. 12479. 32168 FM1 NATURAL-GAS	REPORT- BEPU Building Utility Performance WEATHER FILE- Phoenix									x AZ	AZ TMY2			
KWH 77242. 0. 108209. 4544. 83434. 0. 4281. 31494. 0. 0. 0. 12479. 32168 FM1 NATURAL-GAS		LIGHTS								_	_			TOTAL
			0.	108209.	4544.	83434.	0.	4281.	31494.	0.	0.	0.	12479.	321684.
			0.	0.	156.	0.	0.	0.	0.	0.	0.	1048.	0.	1205.

TOTAL ELECTRICITY 321684. KWH 9.357 KWH /SQFT-YR GROSS-AREA 9.357 KWH /SQFT-YR NET-AREA TOTAL NATURAL-GAS 1205. THERM 0.035 THERM /SQFT-YR GROSS-AREA 0.035 THERM /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.73
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 64

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

6. Proposed – ES-D

REPORT- ES-D Energy Cost Summa		WEATHER FI	LE- Phoenix	AZ TMY2		
UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE (\$)	VIRTUAL RATE (\$/UNIT)	RATE USED ALL YEAR?
Avg Elec Rate	ELECTRICITY	EM1	321684. KWH	28501.	0.0886	YES
Avg Gas Rate	NATURAL-GAS	FM1	1205. THERM	1114.	0.9250	YES
				======= 29615.		

ENERGY COST/GROSS BLDG AREA: 0.86 ENERGY COST/NET BLDG AREA: 0.86