

# **The Pennsylvania State University New Steam Services Building At The West Campus Steam Plant**

Mitchell Seltzer  
Option - Mechanical  
Advisor - Dr. Bahnfleth  
April 9th, 2019





# PSU Steam Services Building

## ★ Building Information

Existing Systems

Chilled Beam Redesign

AHU Redesign

Depth Comparison

Structural Breadth

Electrical Breadth

Final Remarks

Acknowledgements

## Building Information

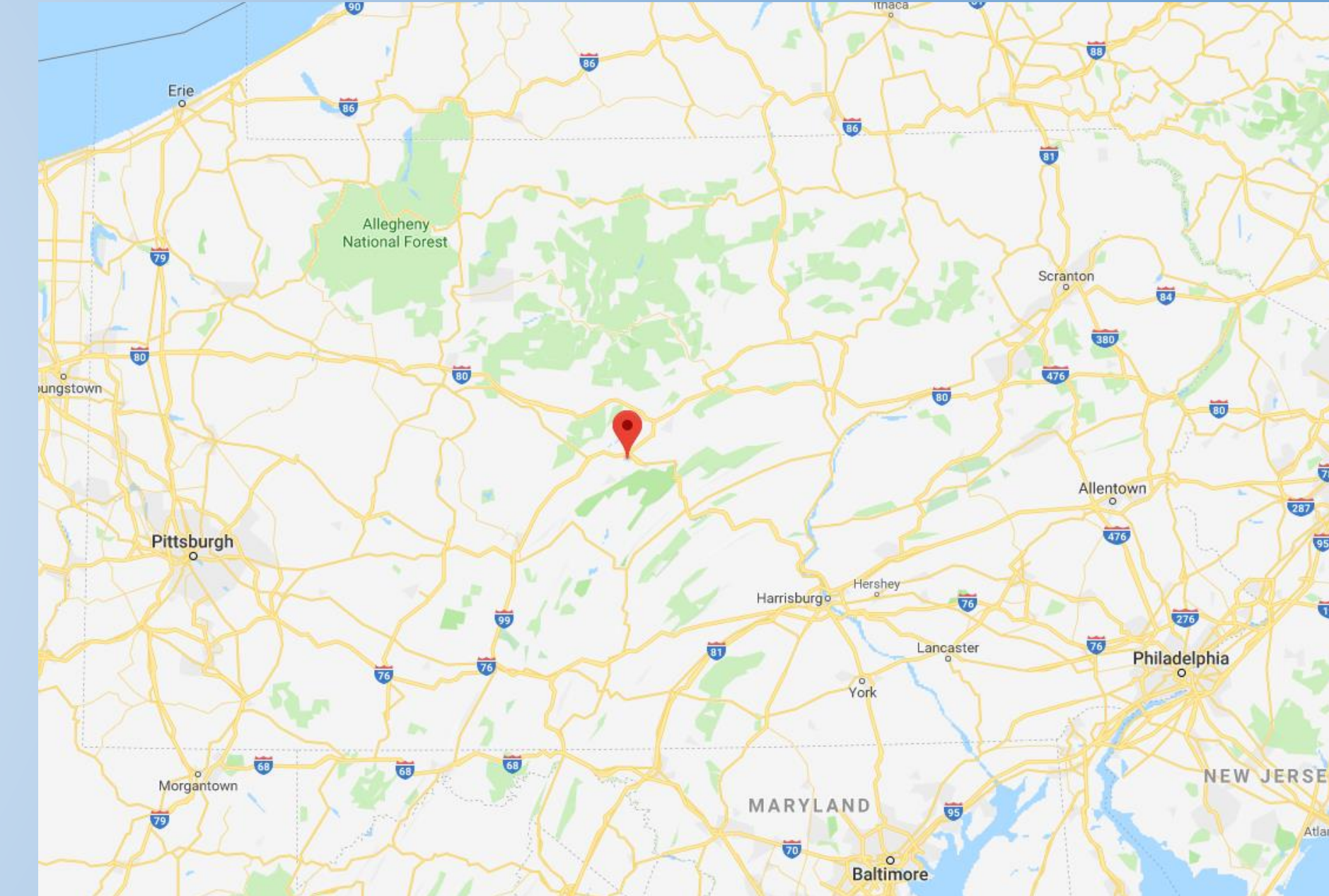
Location: University Park, Pennsylvania

Use: Mixed use of Office and Workshop

Size: 33,420 SQFT

Stories: 3 above grade and a partial basement

Construction Date: July 2018-July 2019





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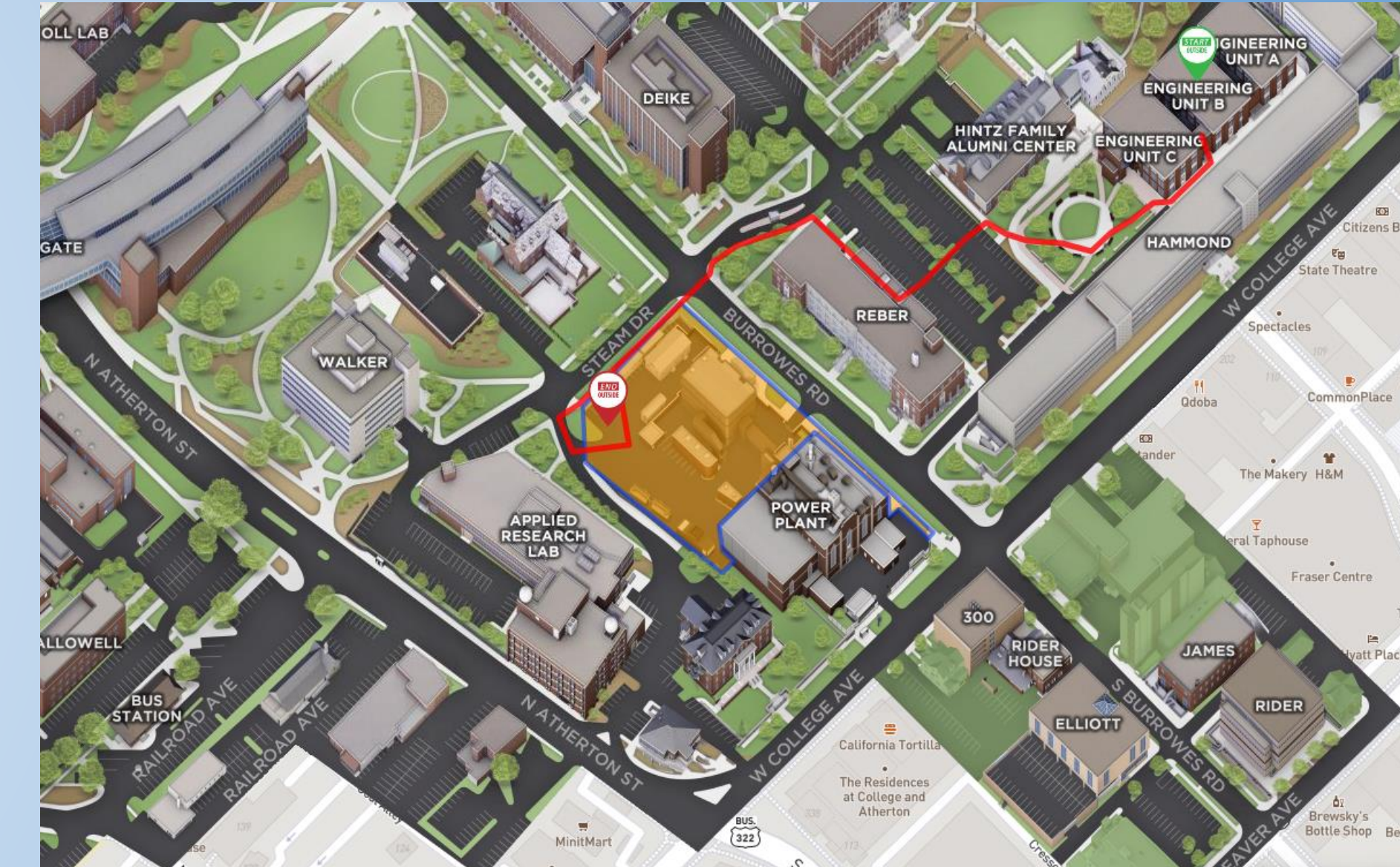
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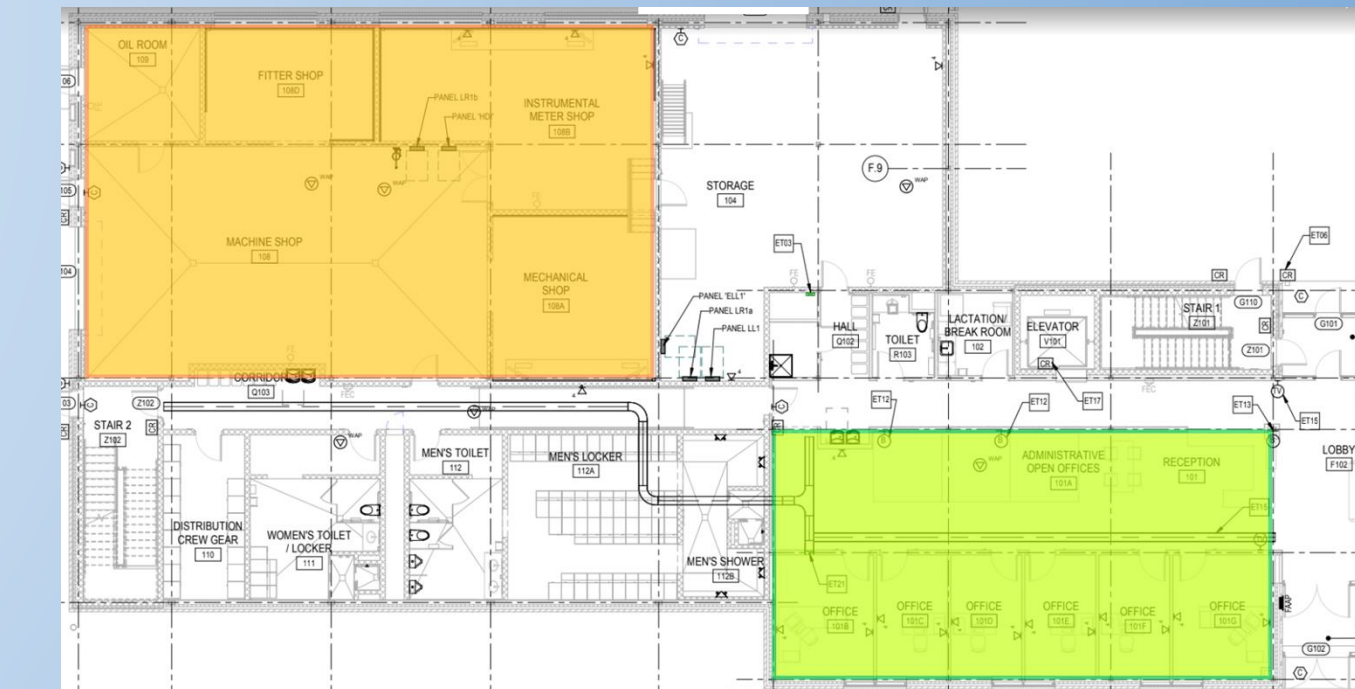
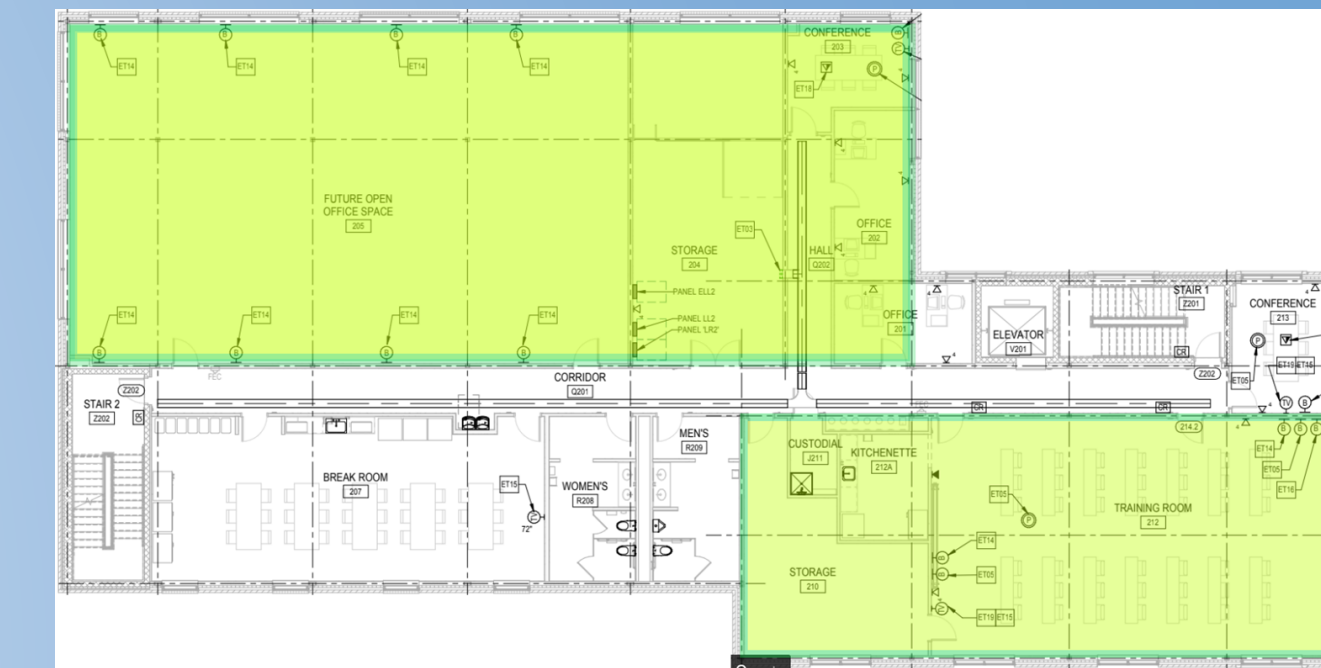
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Owner

Penn State Office of Physical Plant

Construction Management

Alexander Building Construction Co.

Architect

Buchart Horn Architects

MEP/Structural Engineer

Buchart Horn Architects

PENNSSTATE



Office of  
Physical Plant

**ALEXANDER**

A BUTZ FAMILY COMPANY



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#### Structural Breadth

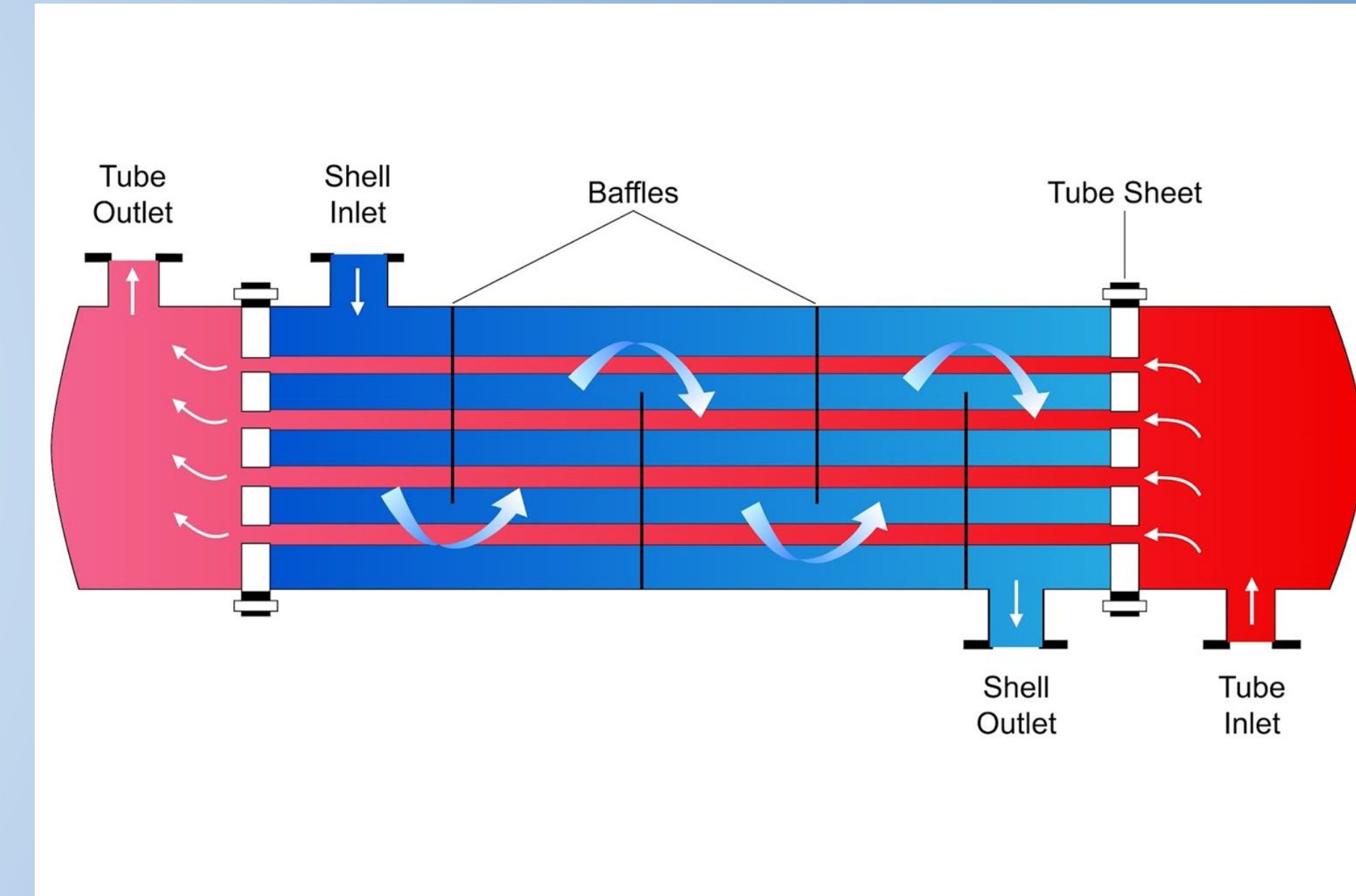
#### Electrical Breadth

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## Existing Systems

### ➤ Shell and Tube Heat Exchanger



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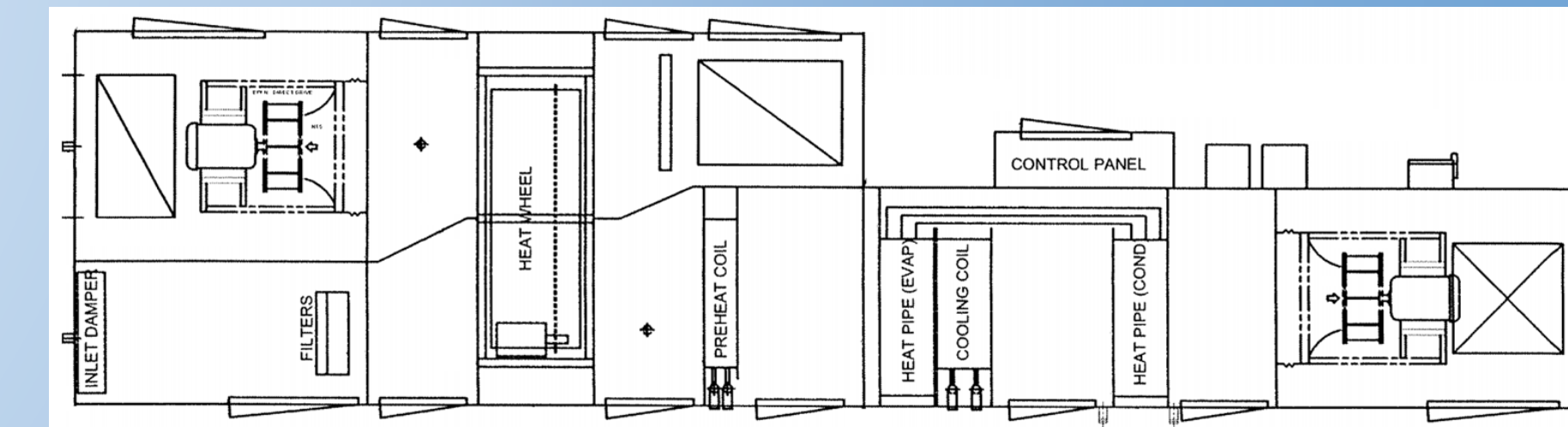
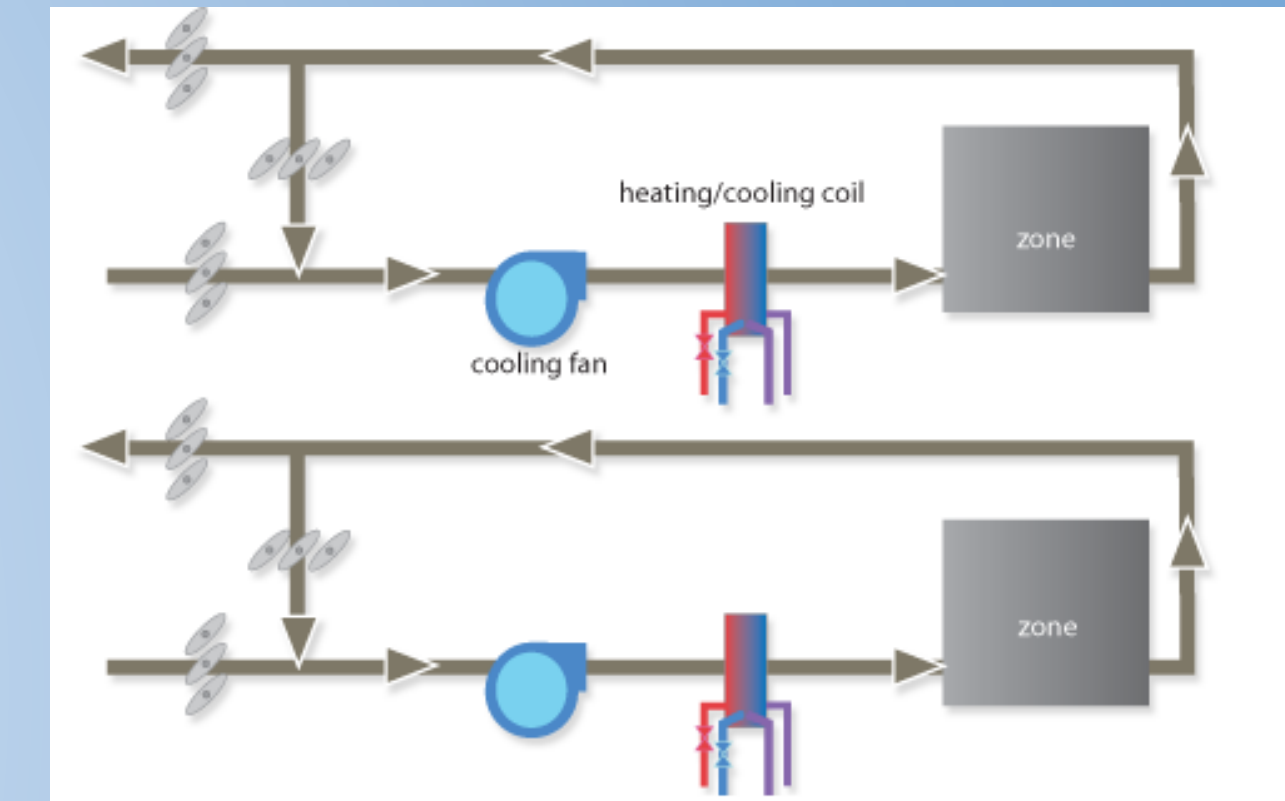
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## Existing Systems

Shell and Tube Heat Exchanger

- Dedicated Outdoor Air Unit with Enthalpy Wheel and Fan Coil Units





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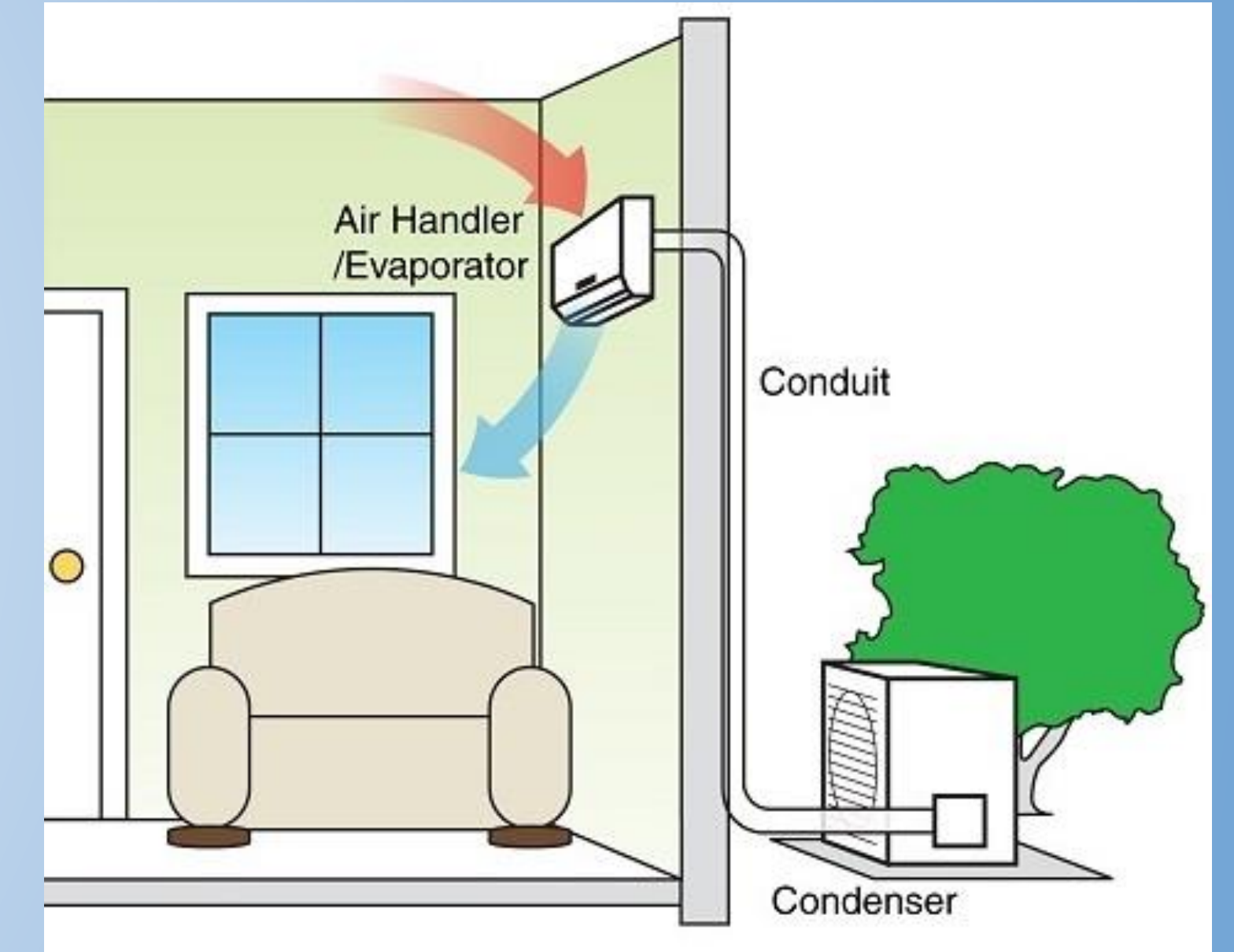
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## Existing Systems

Shell and Tube Heat Exchanger

Dedicated Outdoor Air Unit with Enthalpy Wheel and Fan Coil Units

➤ Mini Split system





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## Existing Systems

Electric Cost	0.08434 \$/kwh
Electric Demand Cost	2.93 \$/kw
Steam Cost	18.39 \$/1000 lbs.
Gas Cost	0.67058 \$/therm
Water Cost	10.19 \$/1000 gal
Chilled Water Cost	0.22 \$/ton-hr



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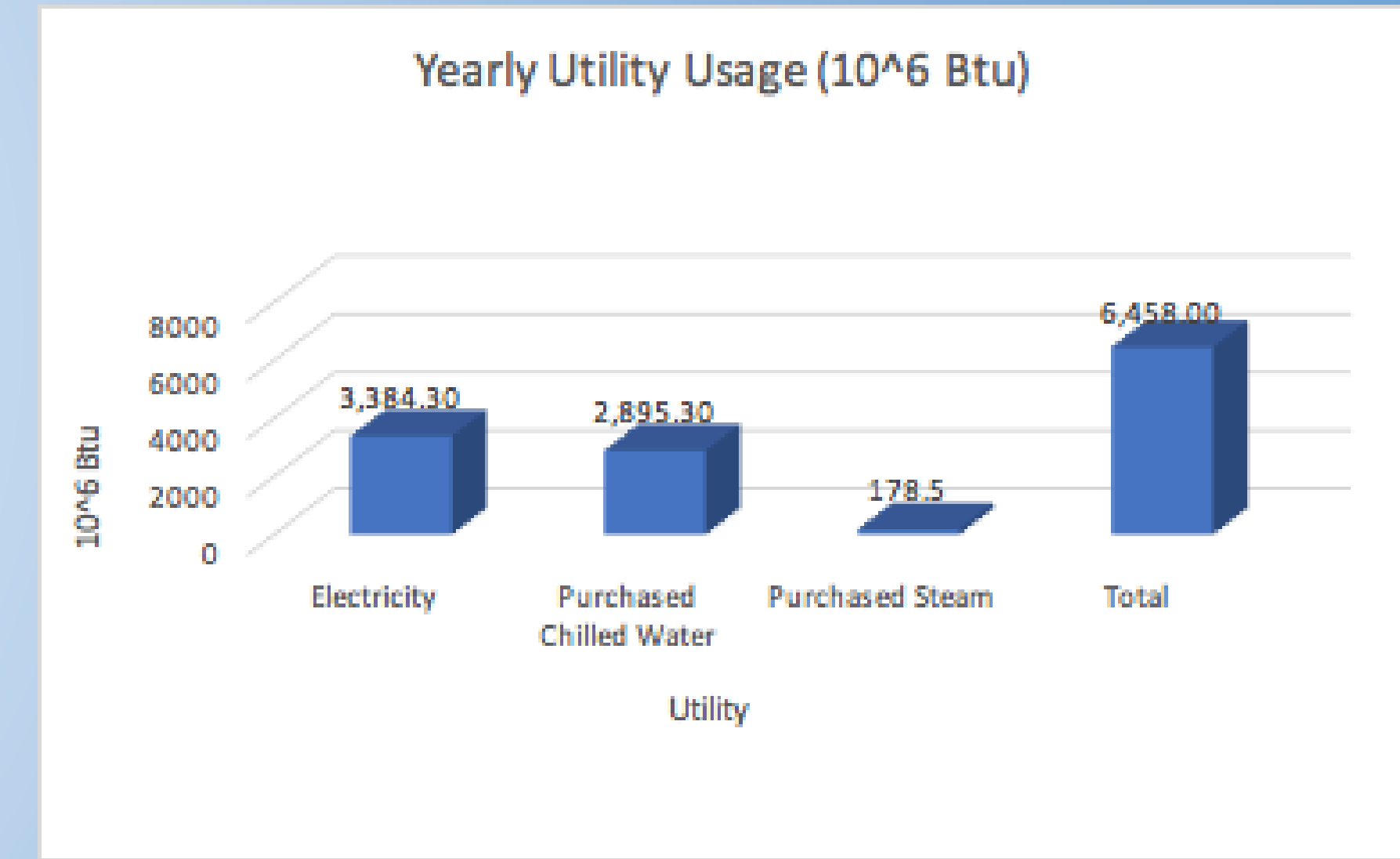
## Electrical Breadth

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## Existing Systems

Total Building Energy per year (kBtu/yr)	6,458,112.00
Total Source Energy per year (kBtu/yr)	12,619,165.00
Energy Cost per year	\$ 97,633.00
Initial Cost	\$ 215,000.00
Maintenance Cost per year	\$ 6,363.65
15 Year Life Cycle Cost	\$ 1,774,949.00





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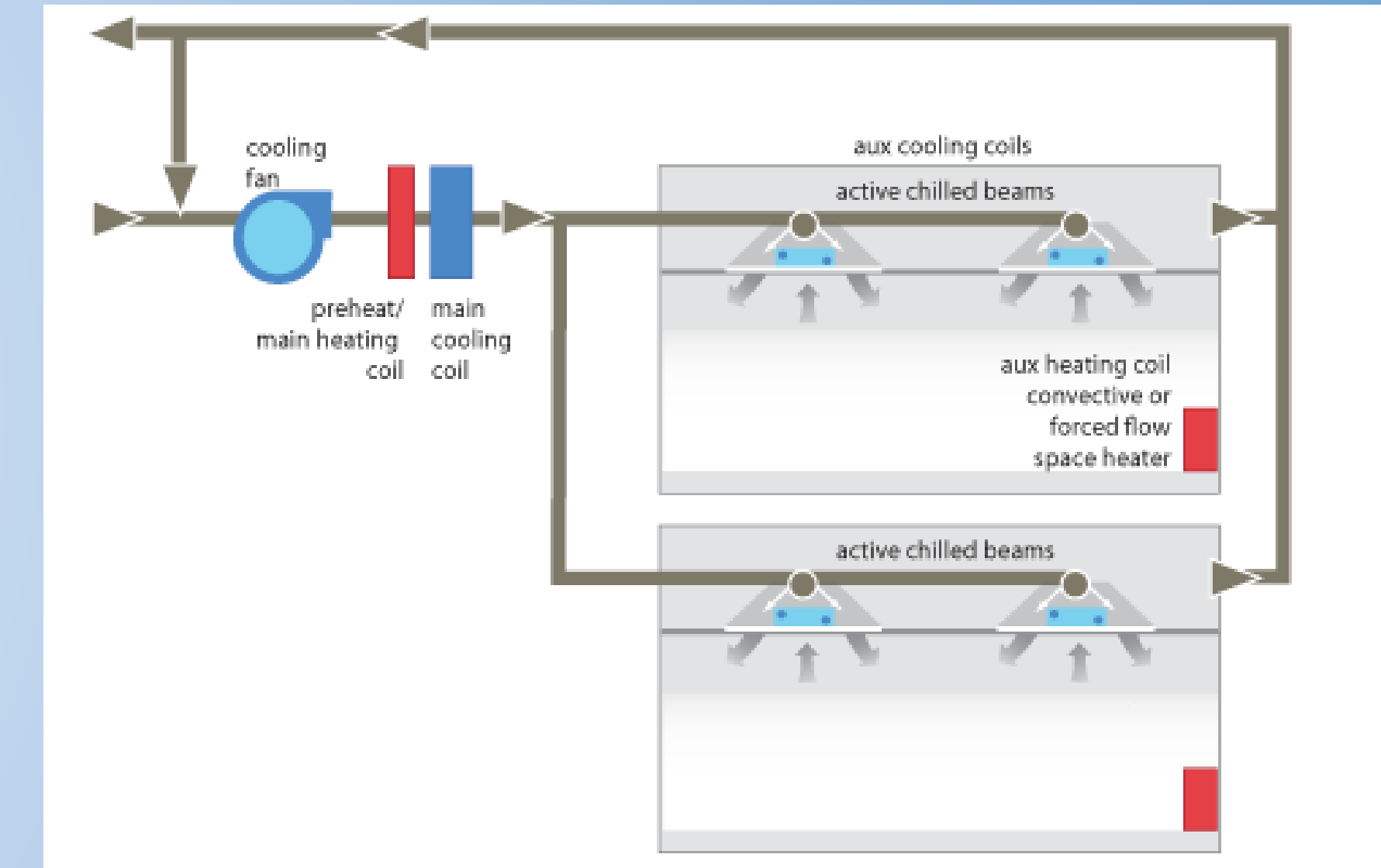
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## Mechanical Redesign: Active Chilled Beams



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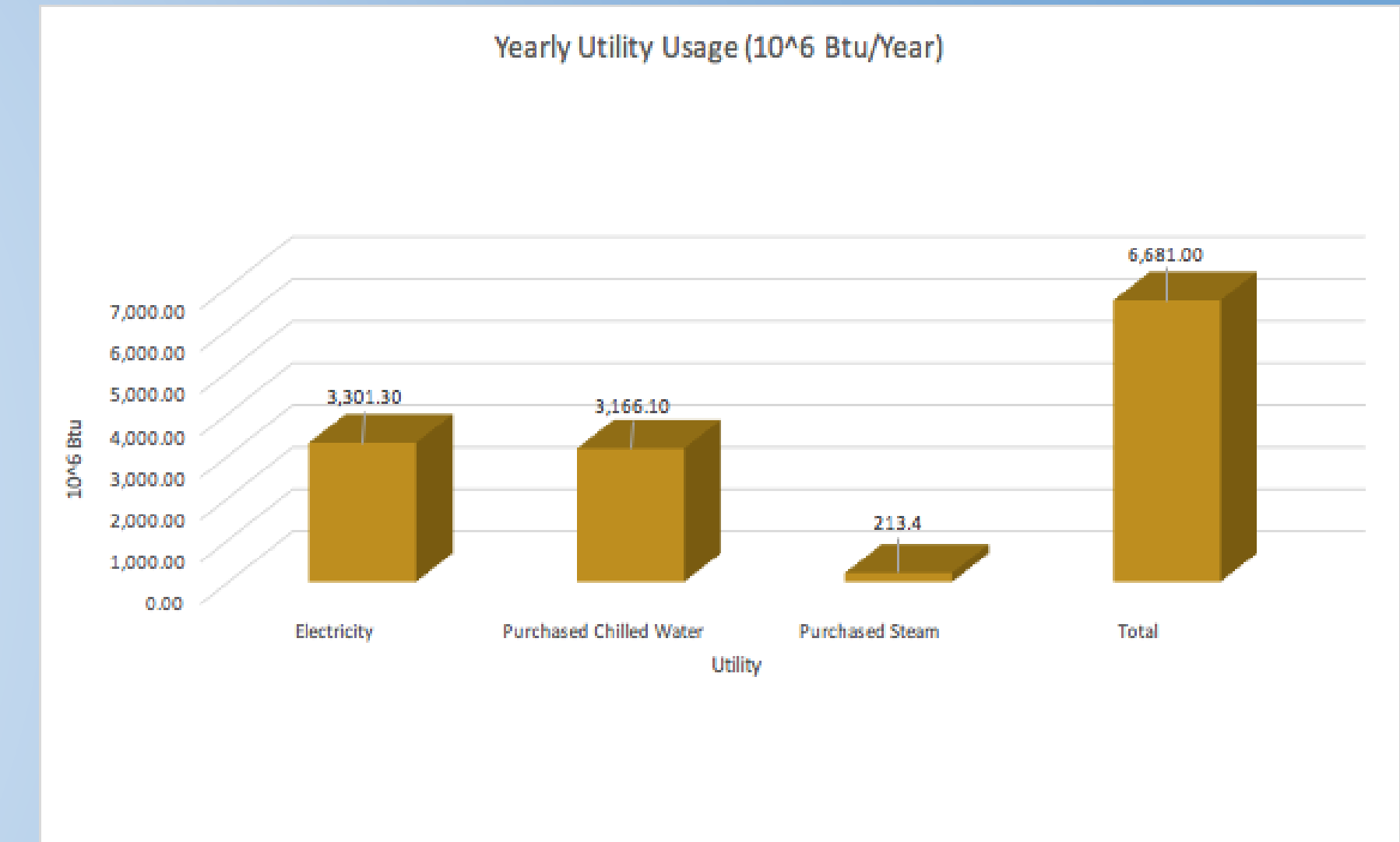
Electrical Breadth

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## Mechanical Redesign: Active Chilled Beams

Total Building Energy per year (kBtu/yr)	6,680,735.00
Total Source Energy per year (kBtu/yr)	12,624,769.00
Energy Cost per year	\$ 96,691.00
Initial Cost	\$ 159,100.00
Maintenance Cost per year	\$ 1,417.45
15 Year Life Cycle Cost	\$ 1,630,726.75
Savings per year	\$ 5,888.20



$$\text{Payback Period} = \frac{\text{Initial Cost}}{\text{Savings}} = \frac{\$159,100}{\$5,888.20} = 27 \text{ years}$$



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★ **Chilled Beam Redesign**

AHU Redesign

Depth Comparison

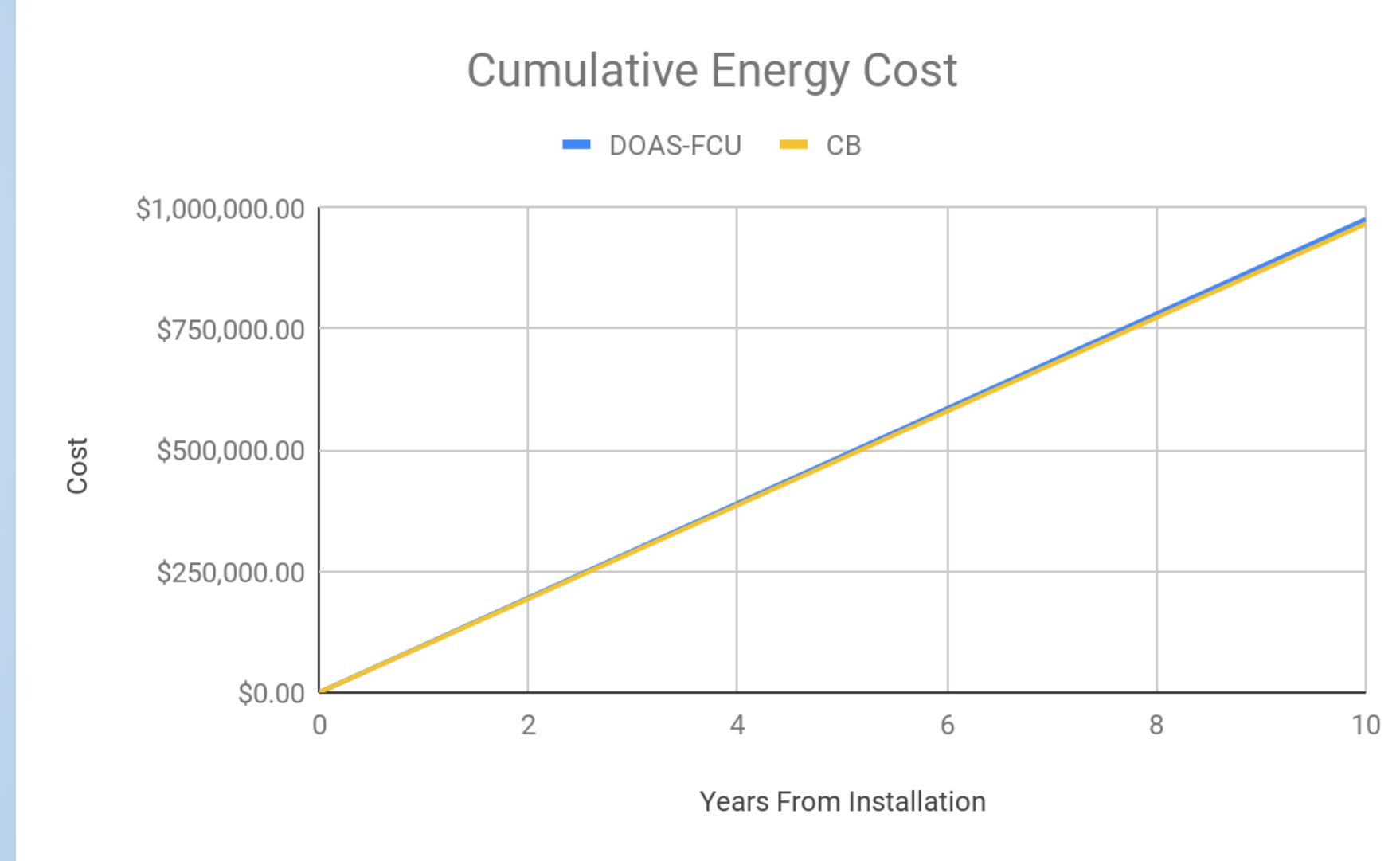
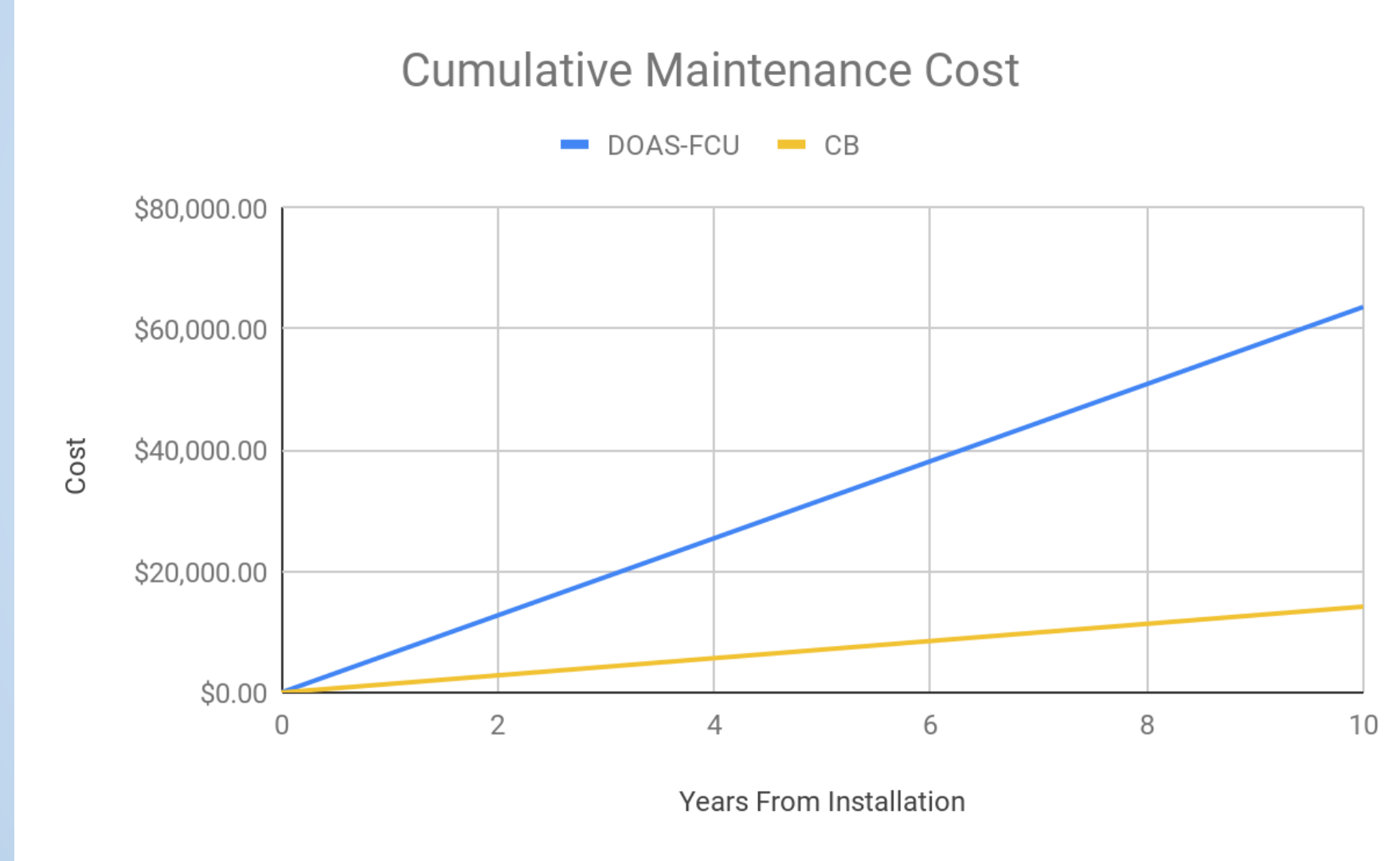
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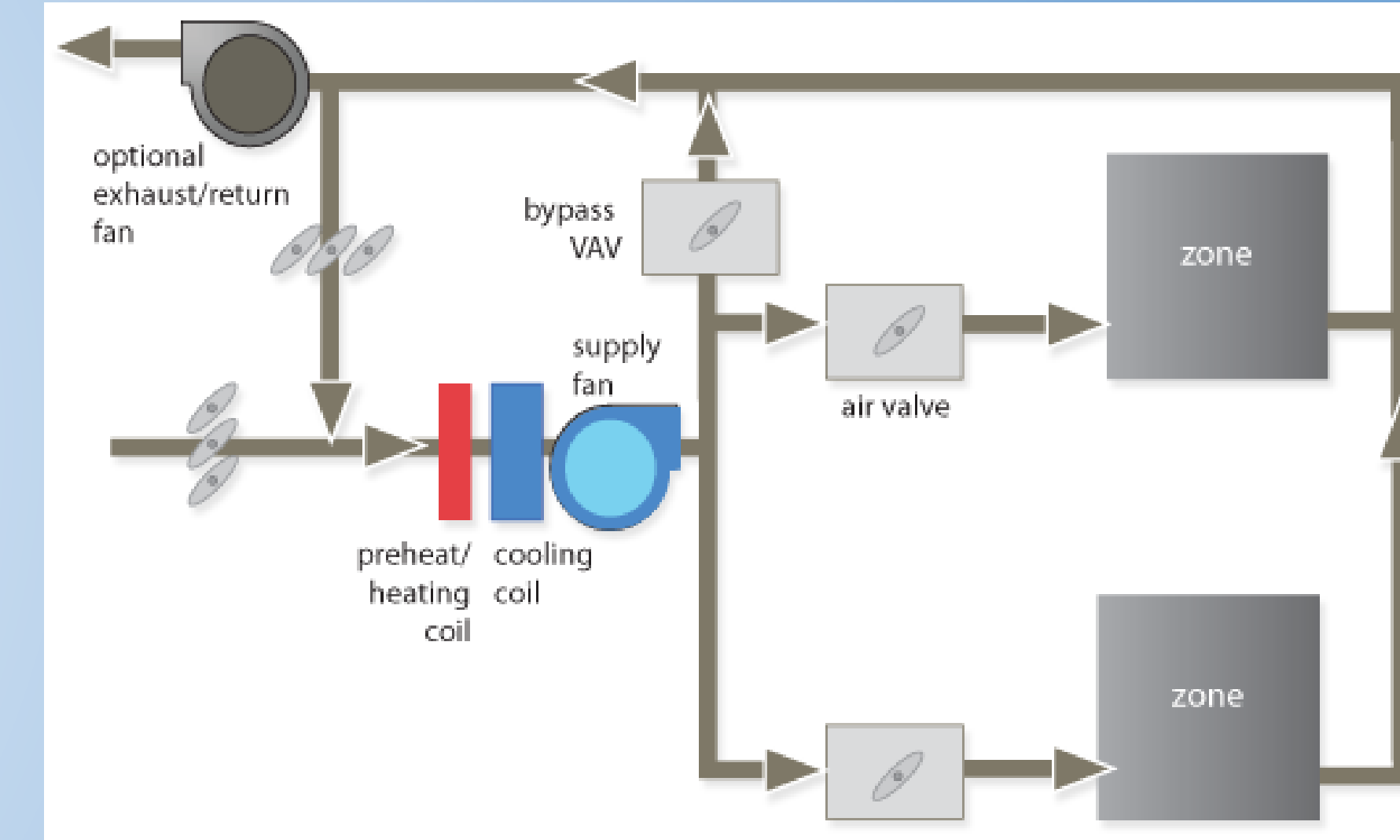
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## Mechanical Redesign: Air Handling Unit Changeover-Bypass System with VAV





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Structural Breadth

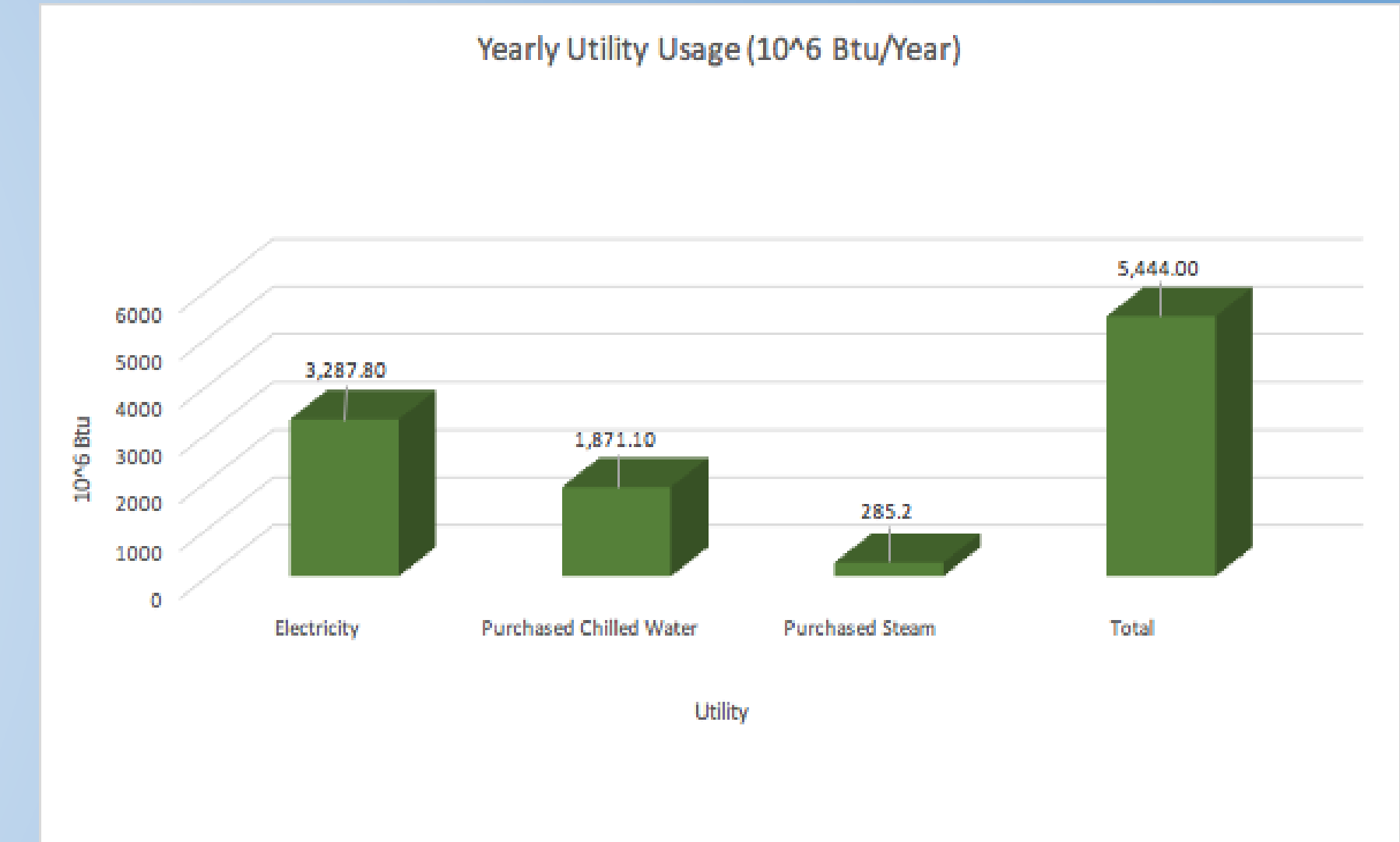
Electrical Breadth

Final Remarks

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## Mechanical Redesign: Air Handling Unit Changeover-Bypass System with VAV

Total Building Energy per year (kBtu/yr)	5,444,031.00
Total Source Energy per year (kBtu/yr)	11,683,876.00
Energy Cost per year	\$ 94,770.00
Initial Cost	\$ 114,000.00
Maintenance Cost per year	\$ 548.20
15 Year Life Cycle Cost	\$ 1,543,773
Savings per year	\$ 8,678.45



$$\text{Payback Period} = \frac{\text{Initial Cost}}{\text{Savings}} = \frac{\$114,000}{\$8,678.45} = 13 \text{ years}$$

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**AHU Redesign**

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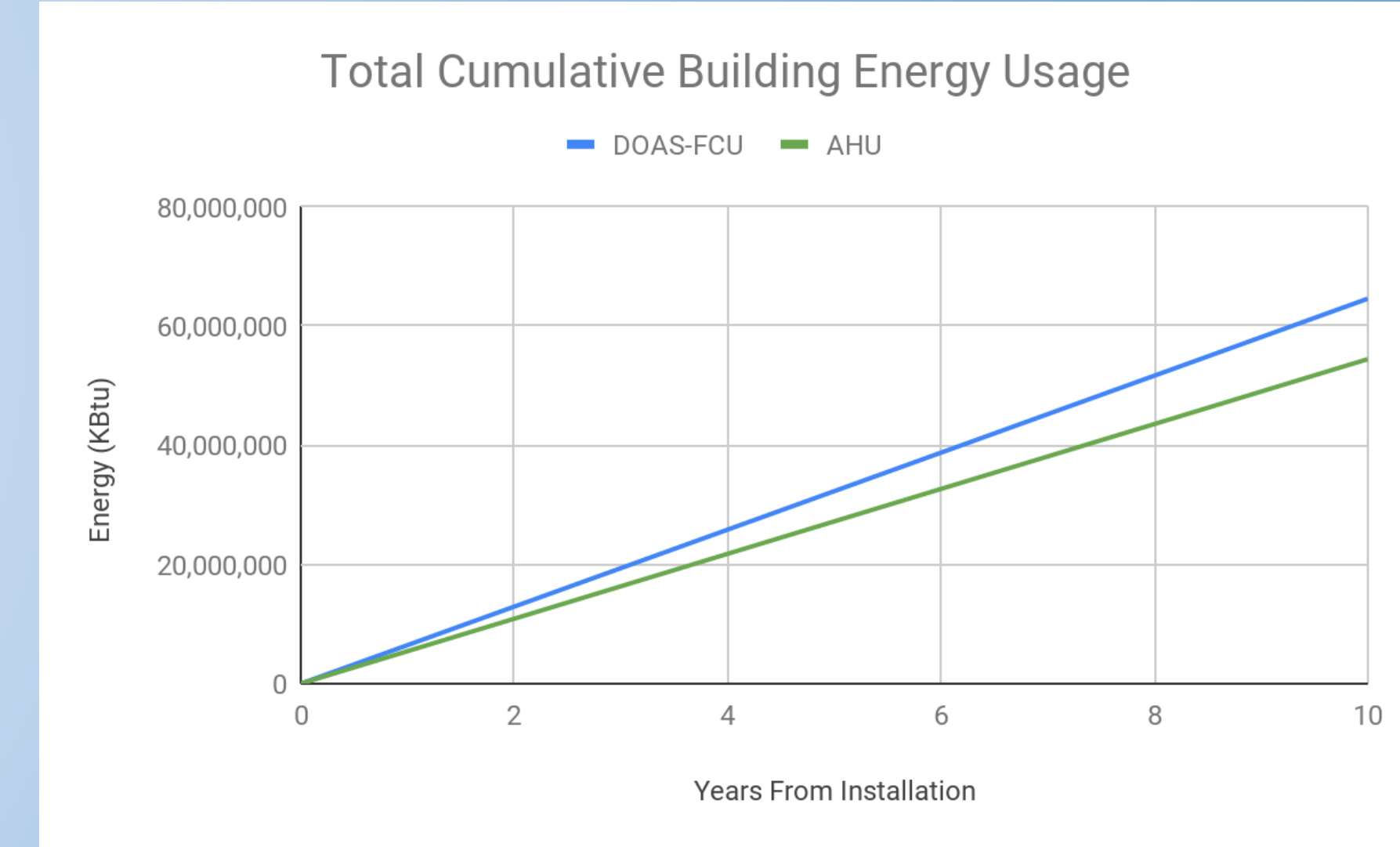
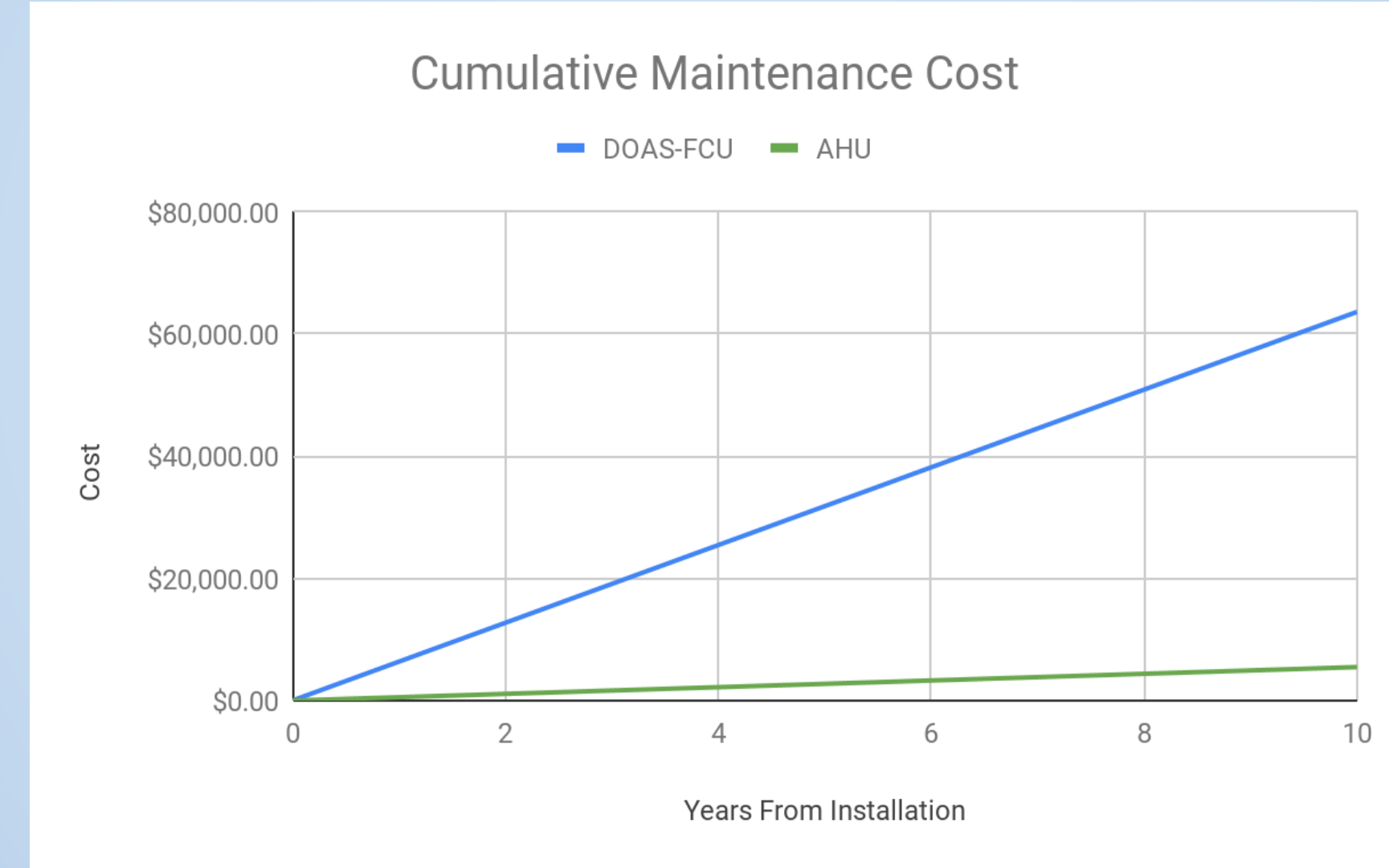
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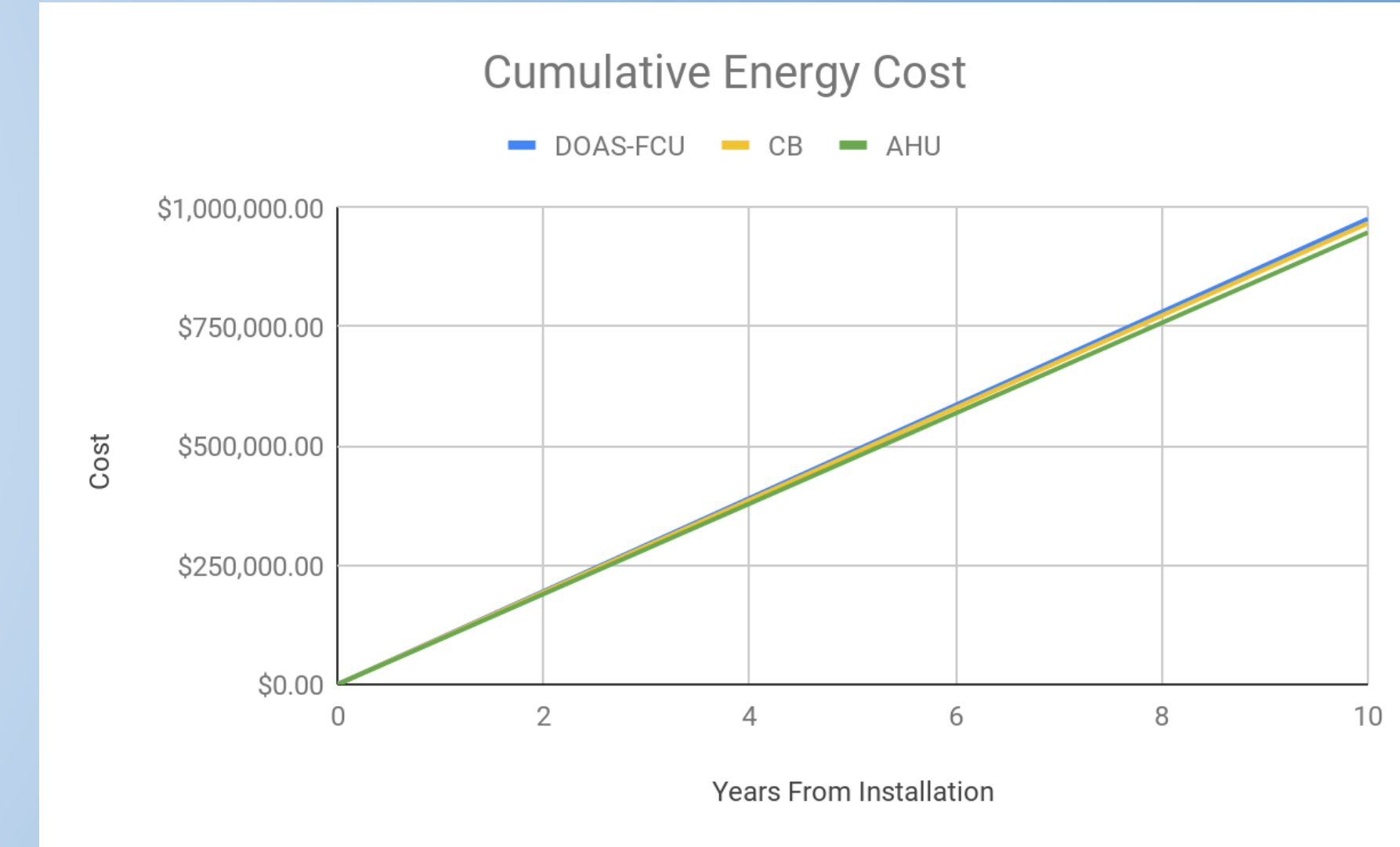
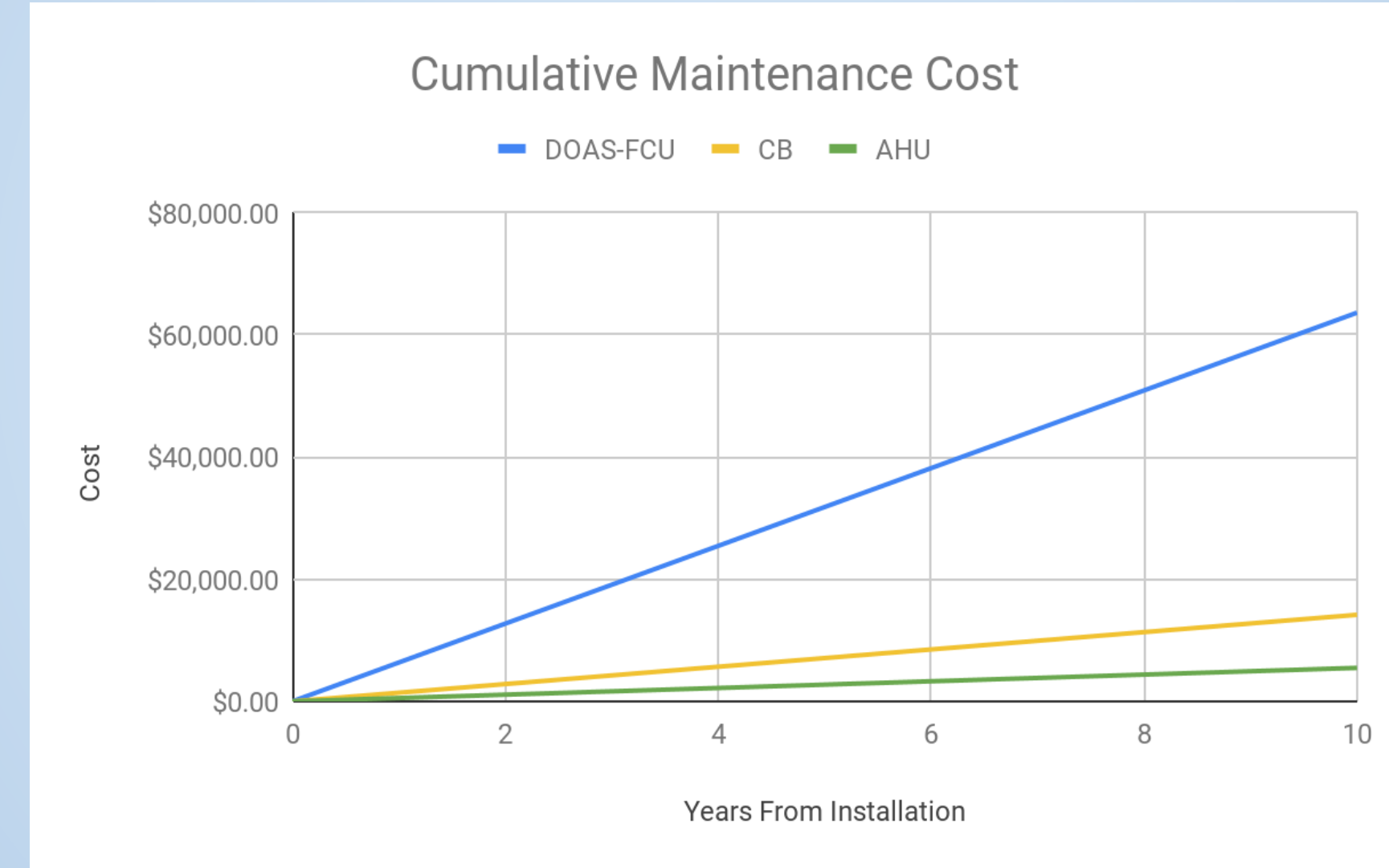
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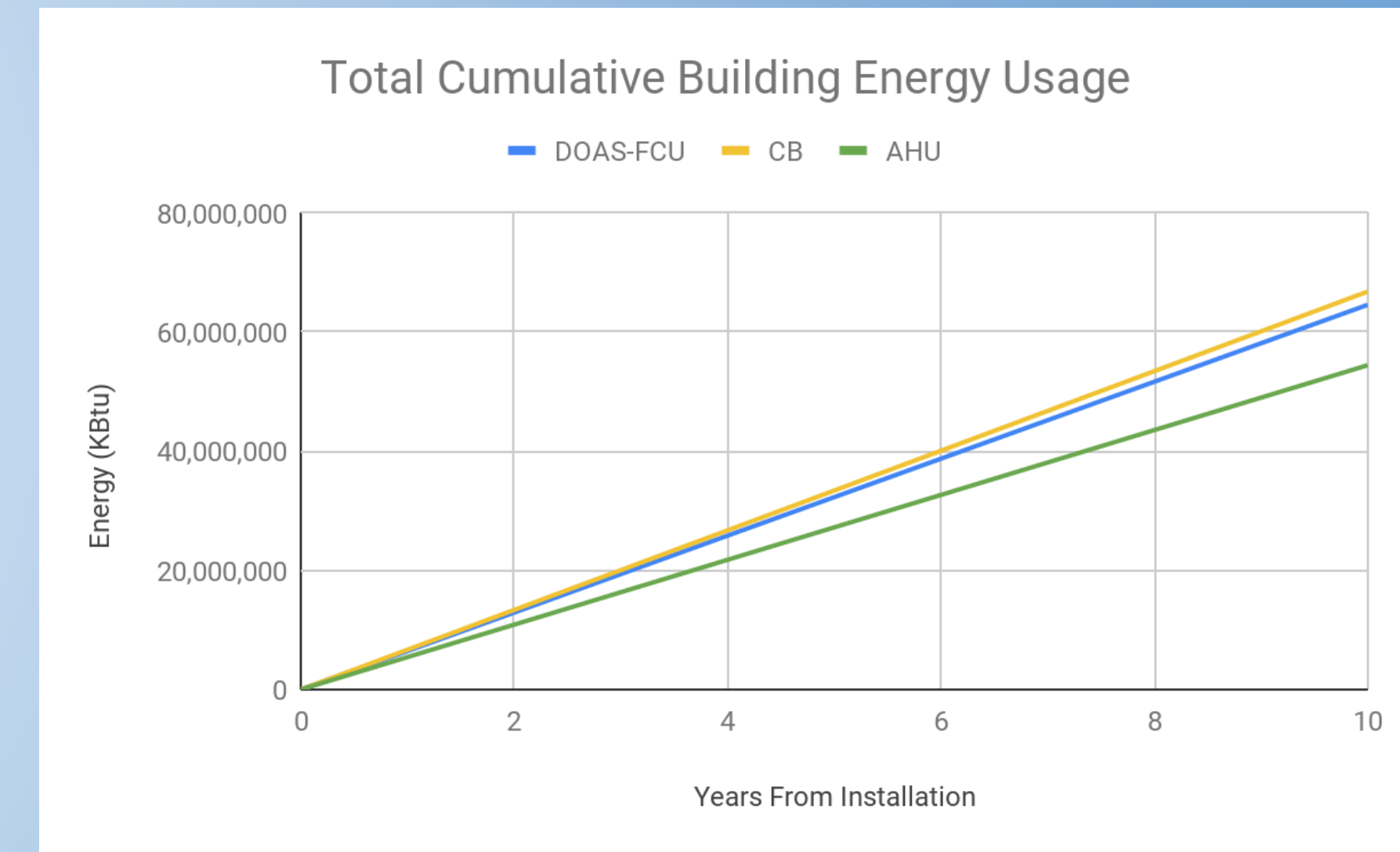
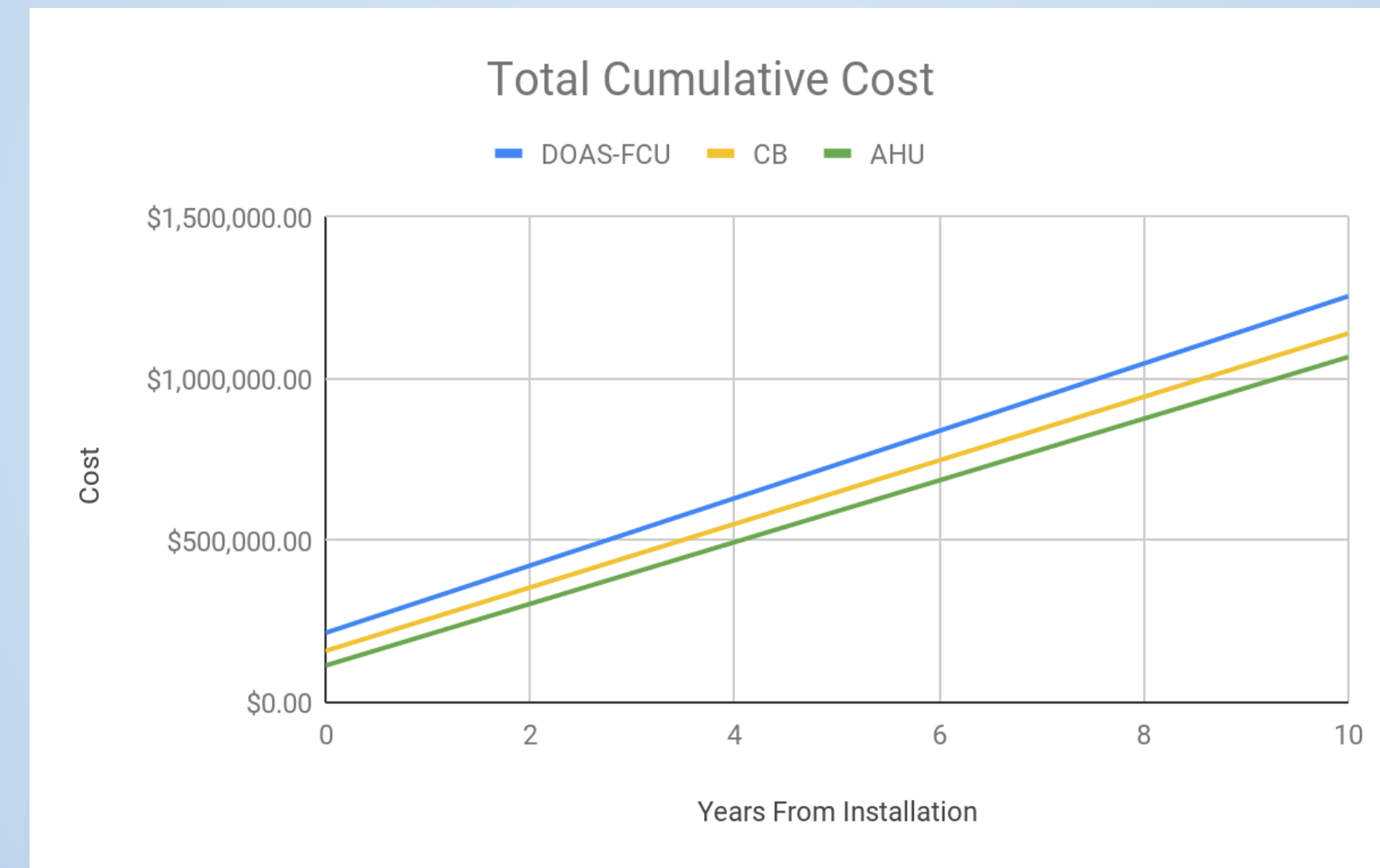
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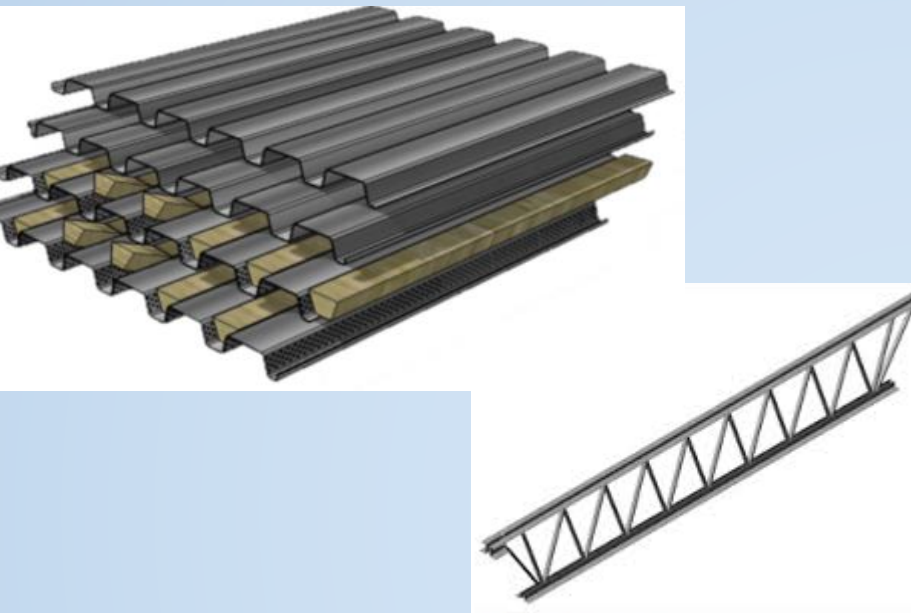
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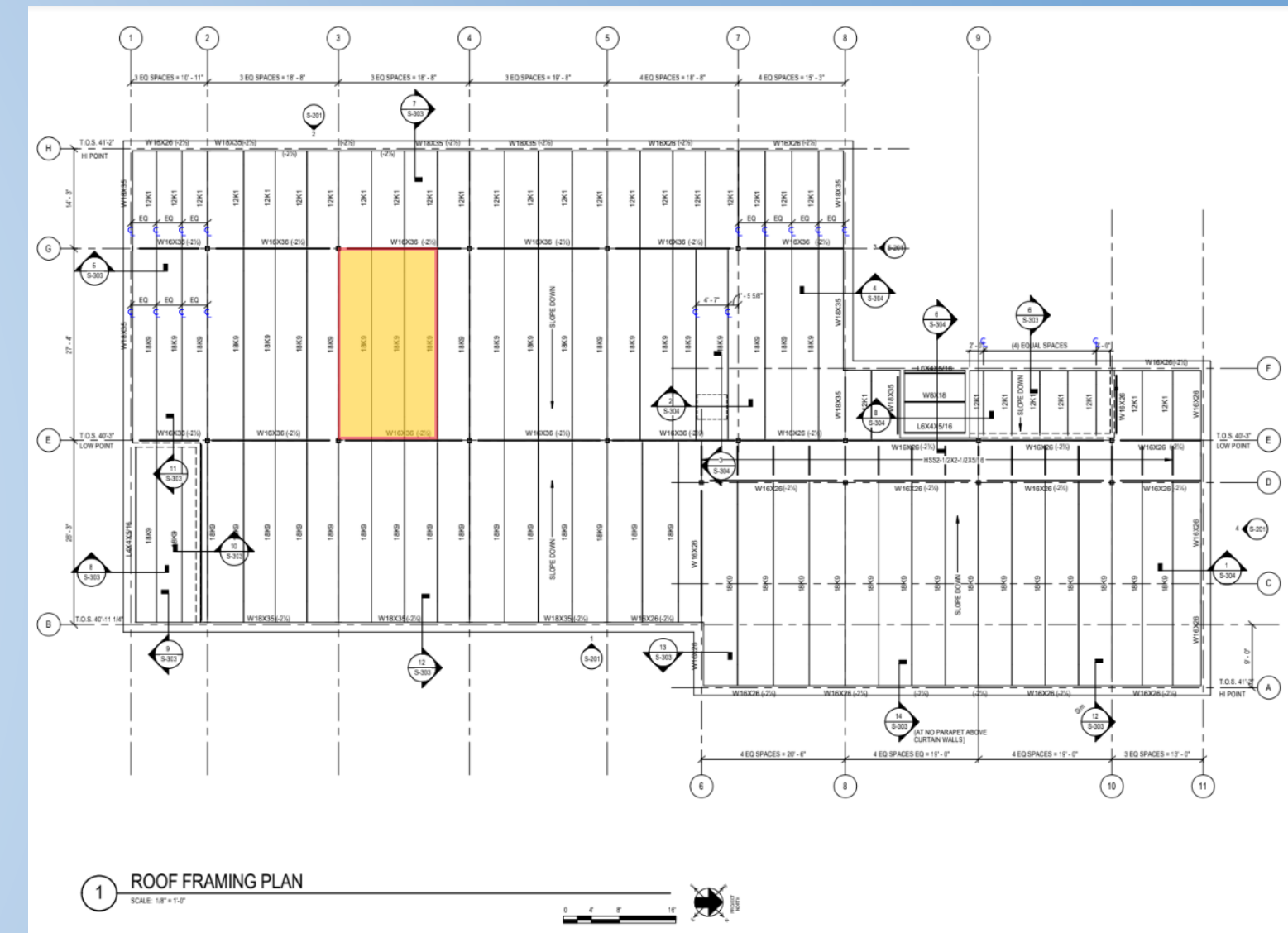
## Structural Breadth



### VERTICAL LOADS FOR TYPE 1.5B

No. of Spans	Deck Type	Max. SDI Const. Span	Allowable T		
			5-0	5-6	6-0
3	B24	5'-10	154 / 120	128 / 90	108 / 69
	B22	6'-11	124 / 167	103 / 126	87 / 97
	B20	7'-9	159 / 209	132 / 157	111 / 121
	B19	8'-5	186 / 250	154 / 188	130 / 145
	B18	9'-1	210 / 289	174 / 217	147 / 167
	B16	10'-3	264 / 369	219 / 277	185 / 214

Joist Span (ft.)	Total Load (plf)		Live Load (plf)		Joist Designation	Joist Wgt. (plf)
	Factored LRFD	Service ASD	1/240	1/360		
F 231	231	154	118	79	14K1	4.9
F 300	300	200	178	119	16K2	5.7
F 334	334	223	198	132	16K3	5.9
F 378	378	252	252	169	18K3	6.3
F 454	454	303	297	198	18K4	6.5
F 508	508	339	339	247	20K4	6.6
F 561	561	374	374	301	22K4	6.7
F 573	573	382	382	277	20K5	7.3
F 615	615	410	410	361	24K4	7.5
F 633	633	422	422	337	22K5	7.3
F 693	693	462	462	404	24K5	8.1
F 754	754	503	503	439	24K6	8.8
F 768	768	512	512	406	22K7	9.0
F 820	820	547	547	519	26K6	9.6
F 825	825	550	550	479	24K7	9.7
F 849	849	566	566	406	20LH04	10.0
F 913	913	609	609	437	20LH05	11.3
F 972	972	648	621	414	18LH05	12.9
F 1186	1186	791	791	561	20LH06	14.0
F 1267	1267	845	845	599	20LH07	14.6
F 1309	1309	873	873	619	20LH08	15.3
F 1429	1429	953	953	675	20LH09	16.2
F 1542	1542	1028	1028	724	20LH10	17.6



$$P_f = 0.7 * C_e * C_t * C_s * I_s * P_g$$

$$1.2 L_D + 1.6 L_L$$

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## Electrical Breadth

LIGHTING AND APPLIANCE PANEL SCHEDULE

PANEL DESIGNATION: **PANEL HM3**      BUS AMPS: **250**      MIN. A.I.C.: **42** KA      MAIN BREAKER: **MLO**      NOTES: **PENTHOUSE MECHANICAL PANEL**  
 LOCATION: **PENTHOUSE**      PHASE: **3**      WIRE: **4**      VOLTAGE: **480Y/277**  
 MOUNTING: **SURFACE**      FED FROM: **PANEL MDS**      NEUTRAL SIZE: **100%**  
 ENCLOSURE: **NEMA 1**      LOCATION:      TOTAL POLES: **42**

CKT NO.	FEEDER BRANCH CIRCUIT DESCRIPTION	AREA	CIRC. NOTES	BREAKER AMP	BREAKER POLES	LOAD ( KVA )			WIRE NO.	WIRE SIZE	GND. SIZE	COND. SIZE	LOAD ( KVA )			BREAKER POLES	BREAKER AMP	CIRC. NOTES	FEEDER BRANCH CIRCUIT DESCRIPTION	AREA	CKT NO.			
						A	B	C					A	B	C									
1	BCU-104-1, BCU-104-2	1ST FL		20	3	2.2			4	12	12	3/4	3.4	12	12	4	3.3		3	15		HRU-M301	PENTHOUSE	2
3		MACH SHOP				2.2											3.3						4	
5								2.2									3.3						6	
7	EFHZ-M301	PENTHOUSE		70	3	1.0			4	4	8	1-1/4				0							8	
9						1.0										0							10	
11								1.0								0							12	
13	SPARE			70	3											0							14	
15																0							16	
17																0							18	
19	SPARE			20	3											0							20	
21																0							22	
23																0							24	
25	SPARE			70	3											0							26	
27																0							28	
29																0							30	
31	SPACE - PFFB					0										0							32	
33	SPACE - PFFB					0										0							34	
35	SPACE - PFFB					0										0							36	
37	SPD			30	3				4	10	10	3/4				0							38	
39																0							40	
41																0							42	

SIDE CONNECTED KVA: 3 3 3      PANEL CONNECTED KVA: 20      PANEL DEMAND KVA: 18      PANEL DEMAND FACTOR: 90%      DERATING FACTOR (80%):      DEMAND LOAD SIZE: 26 AMPS

COND SIZE	GND. SIZE	WIRE SIZE	WIRE NO.	LOAD ( KVA )			BREAKER		CIRC. NOTES	FEEDER BRANCH CIRCUIT DESCRIPTION	AREA	CKT NO.
				A	B	C	POLES	AMP				
3/4	12	12	4	3.3			3	15		HRU-M301	PENTHOUSE	2
						3.3						4
						3.3						6

COND SIZE	GND. SIZE	WIRE SIZE	WIRE NO.	LOAD ( KVA )			BREAKER		CIRC. NOTES	FEEDER BRANCH CIRCUIT DESCRIPTION	AREA	CKT NO.
				A	B	C	POLES	AMP				
3/4	8	8	4	5.8			3	50		AHU-M301	PENTHOUSE	2
						5.8						4
						5.8						6

Original Circuit and Panel



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Total Building Energy savings per year (kBtu/yr)	1,014,081
Total Source Energy savings per year (kBtu/yr)	935,289
Initial Cost savings	\$ 101,000.00
Cost savings per year	\$ 8,678.45
15 Year Cost Savings	\$ 231,176.75
25 Year Cost Savings	\$ 317,961.25



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Mr. Moses Ling

Proferror - PSU AE Department

Mr. Daniel Scott

Construction Services - PSU OPP

Mr. Paul Moser

Superintendent - Steam Services PSU OPP

Mr. Bryan Ondrasik

Mechanical Engineer - Buchart Horn, Inc.

Mr. Justin Seltzer

Project Engineer - Alexander Building Construction Co.

Mr. Christopher Varughese

Mechanical Engineer - MG Engineering

Mr. Buck Nye

President - H.C. Nye Company, Inc.

# Thank You



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H.C. Nye Company, Inc.

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# Appendix

Unit Submittal		
		
<small>2425 South Yukon Ave - Tulsa, Oklahoma 74107-2728 - Ph. (918) 583-2266 Fax (918) 583-6094 AAONEcat32 Ver. 4.281 (SN: 5728272-)</small>		
<b>RL-045-3-0-NWON-EHJ: ZGED-D00-KAW-000-D00AD00-00-00000000B</b> Tag: RTU# 1		
Job Name:	Mitchell Setzer PSU	Unit Submittal For:
Job Number:	Job #100008739	Unit Submittal Date:
		April 03, 2019
Base Option	Description	
<b>R</b>	Series	Roof Top Unit
<b>L</b>	Generation	Tenth Generation
<b>045</b>	Unit Size	Forty Five
<b>3</b>	Voltage	460V/3Ø/60Hz
<b>0</b>	Inter. Protection	Standard
<b>N</b>	Cooling - Style	Air Handling Unit w/ Draw-Through Supply Fans w/ End Control Panel w/o Vestibule
<b>W</b>	Cooling - Configuration	Chilled Water 6R High CFM Coil
<b>0</b>	Cooling - Coating	Standard
<b>N</b>	Cooling - Staging	Single Serpentine 10 FPI (CHW)
<b>E</b>	Heating - Type	Hot Water Std
<b>H</b>	Heating - Designation	2 Row Coil D
<b>J</b>	Heating - Staging	Half Serpentine (HW)

Feature Option	Description	
<b>Z</b>	1A. Return / Outside Air Section	Power Return (Plenum)
<b>G</b>	1B. R/A Blower Configuration	2 Blowers (Prem eff mtr)/ 2-motors 2-VFDs
<b>E</b>	1C. R/A Blower	Blower E (27" Diameter - Plenum)
<b>D</b>	1D. R/A Motor	3.0 hp (1170 rpm)
<b>D</b>	2. O/A Control	Full Mod Actuator w/ Enthalpy Limit
<b>0</b>	3. Discharge Locations	Bottom Discharge
<b>0</b>	4. Return Locations	Bottom Return Low CFM
<b>K</b>	3A. S/A Blower Configuration	2 Blowers w/ Prem eff mtr) w/ 2-VFD.s
<b>A</b>	3B. S/A Blower	Blower A (27" Diameter)
<b>W</b>	3C. S/A Motor	10 hp (1760 rpm)
<b>0</b>	6A. Pre-Filter	2" Pleated (Std Position)
<b>0</b>	6B. Final Filter	Standard
<b>0</b>	8C. Filter Options	Standard
<b>D</b>	7. Refrig. Control	115V Outlet Factory Wired
<b>0</b>	8. Refrig. Options	Standard
<b>0</b>	9. Refrig. Accessories	Standard
<b>A</b>	10. Power Options	250 Amps Power Switch
<b>D</b>	11. Safety Options	R/A & S/A Smoke Detector
<b>0</b>	12. Controls	Standard
<b>0</b>	13. Special Controls	Terminal block with Isolation Relays for Thermostat Control
<b>0</b>	14A. Preheat Configuration	Std (No Preheat)
<b>0</b>	14B. Preheat Sizing	Standard (No Preheat)
<b>0</b>	16. Option Boxes	Standard
<b>0</b>	16. Cabinet Options	Standard
<b>0</b>	17. Cabinet Options	Standard - Double-wall R-13 foam insulation & stainless steel drain pan
<b>0</b>	18. Customer Code	Standard
<b>0</b>	19. Code Options	Std ETL USA Listing
<b>0</b>	20. Unit Splits	Standard (One Piece Unit)
<b>0</b>	21. Evap and Water Condenser	Std (No Evap or Water Condenser)
<b>0</b>	22. Control Vendors	Standard
<b>B</b>	23. Type	Standard (Includes 'Gray Paint')

Unit Rating									
									
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<b>Job Information</b>			<b>Unit Information</b>						
Job Name:	Mitchell Setzer PSU		Approx. Op./Ship Weights:	8864 / 8687 lbs. (±5%)					
Job Number:	Job #100008739		Supply CFM/ESP:	15946 / 0.75 in. wg.					
Site Altitude:	0 ft		Pre-Filter FV / Qty:	318.92 fpm / 18					
			Return CFM/ESP/TSP:	15946 / 0.75 / 1.10 in. wg.					
			Outside CFM:	3127					
			Ambient Temperature:	86 °F DB / 74 °F WB					
			Return Temperature:	79.3 °F DB / 65 °F WB					
<b>Static Pressure</b>			<b>Heating Section</b>						
External:	0.75 in. wg.		Economizer:	0.15 in. wg.					
Coil:	0.60 in. wg.		Heating:	1.07 in. wg.					
Filters Clean:	0.12 in. wg.		Cabinet:	0.30 in. wg.					
Dirt Allowance:	0.35 in. wg.		Total:	3.34 in. wg.					
<b>Cooling Section</b>			<b>PreHeat Type:</b>						
Total Capacity:	Gross	Net	Std (No Preheat)						
Sensible Capacity:	679.05	644.91 MBH	<b>Heating Type:</b>						
Latent Capacity:	474.45	440.31 MBH	Hot Water Heat						
Mixed Air Temp:	204.60 MBH		<b>Heating CFM:</b>						
Entering Air Temp:	80.61 °F DB	66.91 °F WB	7000						
Lv Air Temp (Coil):	80.61 °F DB	66.91 °F WB	<b>Total Capacity:</b>						
Lv Air Temp (Unit):	52.45 °F DB	52.19 °F WB	228.7 MBH						
Supply Air Fan:	54.42 °F DB	53.02 °F WB	<b>OA Temp:</b>						
SA Fan RPM / Width:	DT - 2 x 270 @ 6.15 BHP Ea.		2.0 DB / 1.0 °F WB						
Return Air Fan:	1268 / 6.069"		<b>RA Temp:</b>						
RA Fan RPM / Width:	2 x 270 @ 2.14 BHP Ea.		80.0 °F DB / 62.0 °F WB						
CW Coil:	922 / 6.130"		<b>Entering Air Temp:</b>						
CW Face Velocity:	36.7 ft² / 6 Rows / 10 FPI		64.7 °F DB / 53.9 °F WB						
	434.8 fpm		<b>Leaving Air Temp:</b>						
			94.7 °F DB / 64.6 °F WB						
			<b>Entering Water:</b>						
			140.0 °F						
			<b>Leaving Water:</b>						
			122.8 °F						
			<b>GPM / Head:</b>						
			27 / 2.8 ft						
			<b>Water Velocity:</b>						
			2.75 fps						
			<b>FA / RD / FPI / FV:</b>						
			10.63 ft² / 2 / 10 / 658.8						
<b>Electrical Data</b>			<b>Chilled Water Coils:</b>						
Rating:	460/3/60		GPM / Water PD (HXC only):						
Unit FLA:	38		108 / 9.96 ft						
			Ent. / Lv. Water Temp:						
			43 / 55.6 °F						
			<b>Water Velocity:</b>						
			3.27 fps						
			<b>Minimum Circuit Amp:</b>						
			42						
			<b>Maximum Overcurrent:</b>						
			50						
			<b>Qty</b>	<b>HP</b>	<b>VAC</b>	<b>Phase</b>	<b>RPM</b>	<b>FLA</b>	<b>RLA</b>
Supply Fan:	2	10.00	460	3	1760	14.0			
Return Fan:	2	3.00	460	3	1170	4.8			
Control Circuit:	1		120	1		2.9			



# PSU Steam Services Building

Building Information

Existing Systems

Chilled Beam Redesign

AHU Redesign

Depth Comparison


Structural Breadth

Electrical Breadth

Final Remarks

Appendix

## Appendix



### Thermostat Terminals

2425 South Yukon Ave - Tulsa, Oklahoma 74107-2726 - Ph. (918) 583-2266 Fax (918) 583-6094  
AAONEcat32 Ver. 4.281 (SN: 8728272-)

1A 1B 1C 1D 2 3 4 5A 5B 5C 6A 6B 6C 7 8 9 10 11 12 13 14A 14B 15 16 17 18 19 20 21 22 23

**RL-045-3-0-NW0N-EHJ: ZGED-D00-KAW-000-D00AD00-00-00000000B**

Tag: RTU# 1  
 Job Name: **Mitchell Setzer PSU** For:  
 Job Number: **Job #100008739** Date: **April 03, 2019**

Terminals Available/Required for Controlling the Unit

Terminal	Description
[R]	24VAC Control Voltage
[E]	Common
[G]	Supply Fan Enable/ Return Fan Enable + Isolation Relay
[A1] & [A2]	Economizer Enable
[S1-] & [S2+]	Supply Fan 1 & 2 - w/2 VFD: Signal (0-10VDC) <i>VFD frequency reference signal control point must be able to handle 2 VFD's connected in parallel. Each drive is rated for 20k ohm input impedance. (SPA is required to provide separate terminals per VFD.)</i>
[PR1-] & [PR2+]	Return Fan 1 & 2 - w/2 VFD: Signal (0-10VDC) <i>VFD frequency reference signal control point must be able to handle 2 VFD's connected in parallel. Each drive is rated for 20k ohm input impedance. (SPA is required to provide separate terminals per VFD.)</i>
[AFS1] & [AFS2]	Air Flow Switch

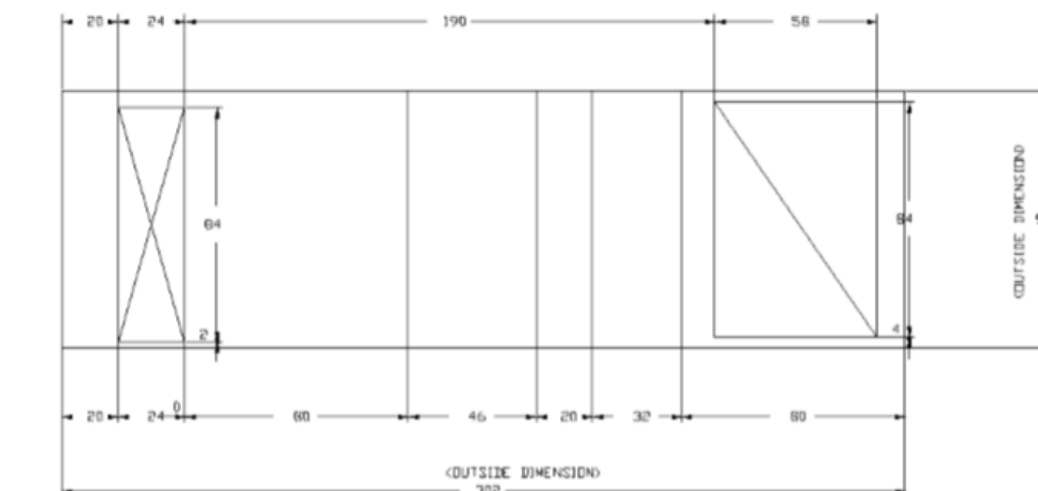



Diagram showing terminal block layout with dimensions: 20, 24, 190, 58, 64, 2, 4, 80, 46, 20, 32, 80, 302, 92. Labels include 'OUTSIDE DIMENSION' and 'UNIT CURB'.

 AAON inc. TULSA OKLAHOMA Total Weight: 6864 / Shipping Weight: 6687 (450)		Configurator: RL-045-3-0-NW0N-EHJ-ZGED-D00-KAW-000-D00AD00-00-00000000B JOB NAME: Mitchell Setzer PSU PURCHASER: _____ PURCHASE ORDER: _____ Rep Contact: _____ Ordered By: _____		UNIT TAG: RTU# 1 SERIAL NO: _____ DATE: 04/03/2019 Software SN: 5728272	
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