
8.0 Construction Cost Impacts – Breadth Topic 2

Any changes to the mechanical or electrical system will certainly have changes in first cost associated with them. By calculating differences in the first cost for each system in consideration, a life cycle analysis can then be performed in order to determine which option will be the most beneficial to the owner over a time span of twenty years. While annual energy cost is important, first cost is also an important factor. Choosing a more expensive first cost system must be justified in some way. Reasons for purchasing a more expensive system could include low annual energy costs, low life cycle cost, or perhaps an environmentally friendly system that is simply more efficient and uses less energy, or one that achieves LEED points if a LEED rating is important to the owner.

The DOAS and VAV system have several areas where initial costs will be significantly different. First, the areas using a DOAS system will use smaller, cheaper air handling units. The DOAS system will also result in smaller ductwork. The VAV system will need to include variable air volume and fan powered boxes to modulate the amount of air supplied to each space. A DOAS system will have additional costs over a VAV system since a second parallel system is necessary for sensible cooling. For this building the sensible system is ceiling radiant cooling panels. The panels and additional copper piping required to supply chilled water to the panel will be an added initial cost of the DOAS system. In addition to mechanical costs changing, the electrical costs associated with the VAV and DOAS systems will be different. Wiring must be supplied to control the VAV and FPB's. Electrical resistance reheat is also necessary for the fan powered boxes. Smaller air handling units for the DOAS system will also result in small wiring requirements. The addition or subtraction of all of the previously mentioned electrical components will also affect the size of feeder wiring and circuit breaker sizes as discussed in section 6.0 Electrical Redesign – Breadth Topic.

The two different chiller options, direct-fired absorption and electric centrifugal, will also result in different first costs. The main difference will be the initial costs for each of the chillers. While the power requirements to the chillers would change, the electric chillers are already in place and would only be replaced, so the existing wiring could be reused. It would be necessary to consider the differences in chiller wiring sizes as well as the size of any step down transformers from the utility in a new construction project. Since those pieces of equipment are already in place for the electric chillers, which has the larger power requirements, the existing equipment will be reused, even if it is somewhat oversized.

The first cost of all major mechanical system components for the DOAS and VAV airside systems are detailed in Table 8.0-1 through Table 8.0-8. Tables 8.0-9 and 8.0-10 summarize the differences in initial electrical costs for VAV and DOAS systems respectively. A more detailed electrical first cost comparison can be found in Appendix E. Table 8.0-11 summarizes the overall cost differences for the VAV and DOAS systems. The results of the first cost analysis determines that a DOAS system for

Straumann USA would approximately cost an additional \$129,000. The varying chiller costs associated with direct-fire absorption and electric centrifugal chillers are summarized in Table 8.0-12. As expected, the absorption chillers do add an increased first cost nearly doubling the cost of installing centrifugal chillers.

VAV Duct Cost					
Rooftop Unit	Exposed/Unexposed	Duct Surface Area (ft ²)	Duct Volume (ft ³) (thickness, 24 gauge)	Density (lb/in ³)	lbs
RTU-1	Unexposed Type (Type 304)	593	1.234	0.285	607.5
RTU-2	Unexposed Type (Type 304)	426	0.886	0.285	436.4
RTU-3	Unexposed Type (Type 304)	78	0.162	0.285	79.6
RTU-4	Unexposed Type (Type 304)	579	1.205	0.285	593.4
RTU-5	Unexposed Type (Type 304)	252	0.524	0.285	257.9
RTU-6	Unexposed Type (Type 304)	301	0.625	0.285	307.9
RTU-7	Exposed (Type 316)	134	0.279	0.29	139.7
RTU-8	Exposed (Type 316)	129	0.269	0.29	134.8
RTU-9	Exposed (Type 316)	176	0.366	0.29	183.2
RTU-10	Exposed (Type 316)	161	0.335	0.29	167.6
Total					2908.1
Cost	2000-3000lbs	\$11.8/lb			\$34,316

Table 8.0-1: VAV Duct Cost

DOAS Duct Cost					
Rooftop Unit	Exposed/Unexposed	Duct Surface Area (ft ²)	Duct Volume (ft ³) (thickness, 24 gauge)	Density (lb/in ³)	lbs
RTU-1	Unexposed Type (Type 304)	516	1.072	0.285	528.1
RTU-2	Unexposed Type (Type 304)	473	0.984	0.285	484.8
RTU-3	Unexposed Type (Type 304)	68	0.141	0.285	69.2
RTU-4	Unexposed Type (Type 304)	287	0.597	0.285	293.8
RTU-5	Exposed (Type 316)	134	0.279	0.29	139.7
RTU-6	Exposed (Type 316)	129	0.269	0.29	134.8
RTU-7	Exposed (Type 316)	176	0.366	0.29	183.2
RTU-8	Exposed (Type 316)	161	0.335	0.29	167.6
Total					2001.3
Cost	2000-3000lbs	\$11.8/lb			\$23,616

Table 8.0-2: DOAS Duct Cost

VAV Box Cost				
VAV Box Inlet Size	VAV Box Max CFM	# of Boxes	Cost per Box	Cost
6"	240	17	\$445	\$7,565
8"	500	40	\$445	\$17,800
10"	850	25	\$500	\$12,500
12"	1300	40	\$500	\$20,000
14"	1720	7	\$535	\$3,745
Total				\$61,610

Table 8.0-3: VAV Variable Air Volume Box Cost

FPB Cost					
FPN Box Inlet Size	FPB Max CFM	kW Heat	# Boxes	Cost per Box	Cost
8"	580	2-3	7	\$1,075	\$7,525
10"	705	3-6	5	\$1,200	\$6,000
12"	1475	5-8	15	\$1,350	\$20,250
14"	1200	4	2	\$1,350	\$2,700
16"	1800	6	2	\$1,550	\$3,100
Total					\$39,575

Table 8.0-4: VAV Fan Power Box Cost

VAV Rooftop Units		
	CFM	Cost
RTU-1	33,000	\$24,000
RTU-2	33,000	\$24,000
RTU-3	6,400	\$10,400
RTU-4	33,000	\$24,000
RTU-5	24,000	\$17,700
RTU-6	24,000	\$17,700
RTU-7	33,000	\$24,000
RTU-8	33,000	\$24,000
RTU-9	33,000	\$24,000
RTU-10	33,000	\$24,000
Total		\$213,800

Table 8.0-5: VAV Air Handling Unit Cost

DOAS Rooftop Units		
	CFM	Cost
RTU-1	4,273	\$11,513
RTU-2	3,328	\$9,675
RTU-3	1,052	\$6,550
RTU-4	3,089	\$9,444
RTU-5	33,000	\$24,000
RTU-6	33,000	\$24,000
RTU-7	33,000	\$24,000
RTU-8	33,000	\$24,000
Total		\$133,181

Table 8.0-6: DOAS Air Handling Unit Cost

VAV Diffuser Cost		
Zone	System Zone Type	Diffuser Cost
RTU-1	VAV	\$26,271
RTU-2	VAV	\$18,873
RTU-3	VAV	\$3,443
RTU-4	VAV	\$25,660
RTU-5	VAV	\$11,155
RTU-6	VAV	\$13,317
RTU-7	VAV	\$4,380
RTU-8	VAV	\$4,380
RTU-9	VAV	\$4,380
RTU-10	VAV	\$4,380
Total		\$116,239

Tale 8.0-7: VAV Diffuser Cost Summary

DOAS Diffuser/Radiant Panel Cost			
Rooftop Unit	VAV/DOAS	Diffuser Cost	Radiant Panel Cost
RTU-1	DOAS	\$0	\$232,677
RTU-2	DOAS	\$0	\$213,594
RTU-3	DOAS	\$0	\$27,067
RTU-4	DOAS	\$0	\$129,440
RTU-5	VAV	\$4,380	\$0
RTU-6	VAV	\$4,380	\$0
RTU-7	VAV	\$4,380	\$0
RTU-8	VAV	\$4,380	\$0
Total		\$17,520	\$602,778

Table 8.0-8: DOAS Diffuser/Radiant Panel Cost Summary

VAV Electric Costs	
Electric Panels	\$29,010
Breakers	\$15,313
Wiring	\$33,537
Conduit	\$249,455
Total	\$327,314

Table 8.0-9: VAV Electrical Costs

DOAS Electric Costs	
Electric Panels	\$14,525
Breakers	\$5,860
Wiring	\$14,770
Conduit	\$108,056
Total	\$143,211

Table 8.0-10: DOAS Electrical Costs

First Cost Summary			
	DOAS	VAV	DOAS Additional First Cost
AHU	\$133,181	\$213,800	(\$80,619)
Radiant Panel	\$602,778	\$0	\$602,778
Diffuser	\$17,520	\$99,595	(\$82,075)
Ductwork	\$23,616	\$34,316	(\$10,700)
VAV/FPB	\$0	\$116,239	(\$116,239)
Mechanical Subtotal	\$777,094	\$463,950	\$313,144
Electrical	\$143,211	\$327,314	(\$184,103)
Total First Cost	\$920,305	\$791,264	\$129,042

Table 8.0-11: DOAS and VAV First Cost Summary

Initial Chiller Cost			
	500 Tons (2)	300 Tons (1)	Total
Electric Centrifugal	\$191,000	\$130,400	\$512,400
Direct-fire Absorption	\$392,000	\$245,000	\$1,029,000

Table 8.0-12: Initial Chiller Cost Summary