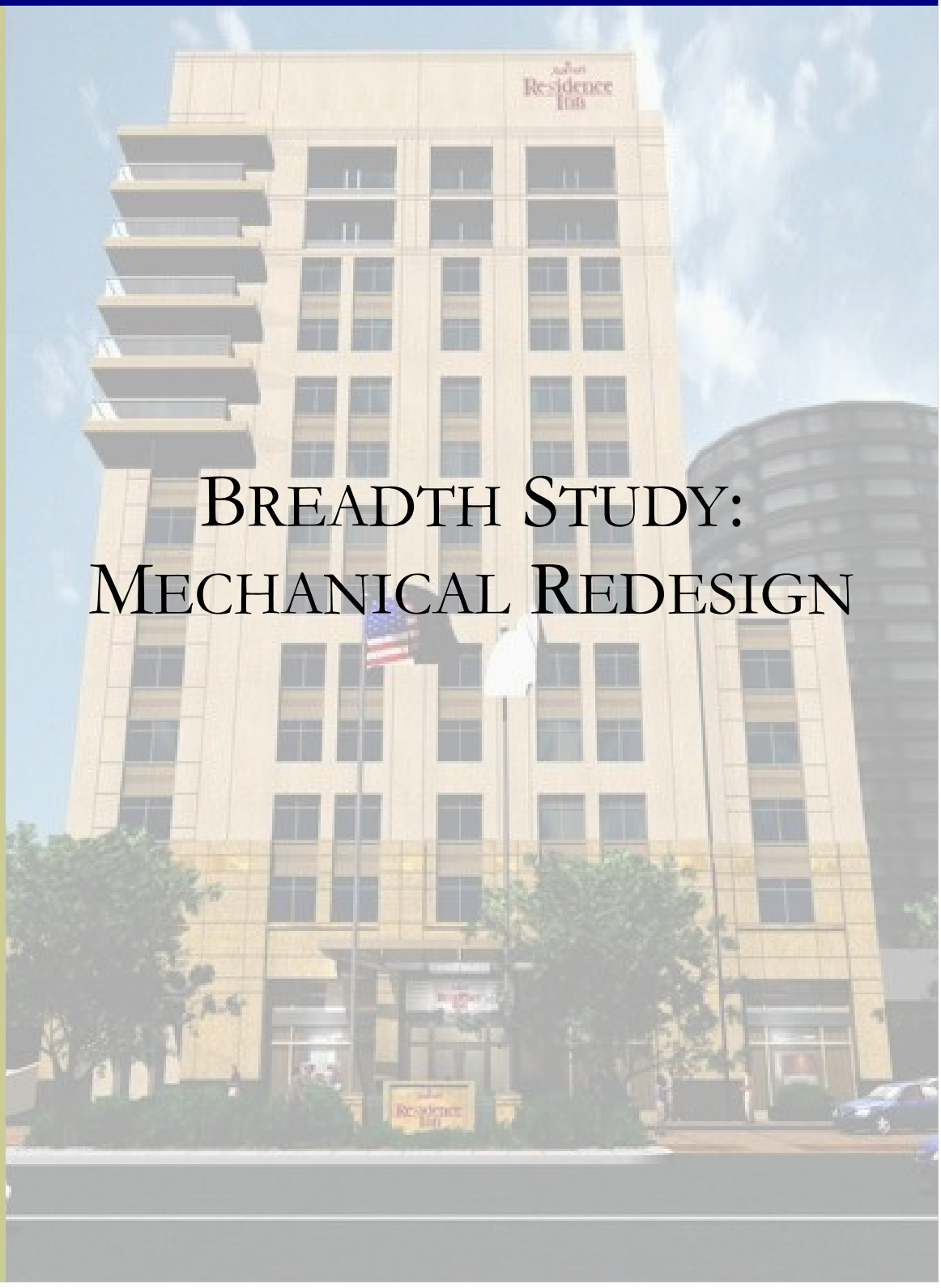
Residence Inn by Marriott, Stamford CT



Breadth Study: Mechanical Redesign

BREADTH STUDY - MECHANICAL REDESIGN

Design Goals

As previously mentioned, the construction of the Residence Inn was delayed by the cost of construction. One way to lower the first cost of the structure has been determined is to change the type of mechanical system located within the building. The owner is willing to sacrifice some level of building quality in order achieve this goal. Therefore, it has been determined that packaged thermal air conditioners, through-wall units, are a good alternative to the original mechanical system utilized in the guest suites. The mechanical system in the non-guest suite portions of the hotel will remain unchanged.

Original System

System Background

The original system designed for the Residence Inn allows guests to control the heating and cooling in their rooms via a system of heat pumps located in every room. Roof top units provide the necessary air distribution and circulation to the guest rooms. In addition to the roof top units located on the roof and penthouse roof, three boilers and two cooling towers are also located on the mechanical roof levels.

This system provides a high level of comfort at low operating costs. Guests have the ability to accurately control their comfort level and to maintain an even comfort level throughout their suite. However, the system's first cost is high; compared to other systems.

Hot and cold water is pumped from the roof to the individual heat pump units located in the guest suites in order to heat or cool the rooms. Air is ducted from the roof top units to the heat pumps where it is conditioned and ducted throughout the room.

System Equipment Cost

To estimate the cost of the original system, a cost estimate prepared by a general contractor during the design phase of the original building is used. Below, in Figure 1, is the estimated quantity and cost of the equipment necessary to condition the guest suites. The costs include labor and other markups such as contractor overhead and profit. The costs of the equipment needed to condition the remaining spaces in the hotel are excluded from the estimate since that equipment will be unchanged by the redesign.

Item	Qty.	Unit	Unit Cost	Cost
Gas Fired Boiler 1800 mbh - complete	3	ea	36,000.00	108,000.00
225 Ton Cooling Tower - complete	2	ea	25,000.00	50,000.00
Package Heat Pumps	188	ea	1,700.00	319,600.00
7320 cfm RTU	1	ea	26,000.00	26,000.00
2000 cfm RTU	1	ea	10,000.00	10,000.00
1200 cfm RTU	5	ea	6,500.00	32,500.00
Air distribution devices	300	ea	110.00	33,000.00
Fire dampers	188	ea	65.00	12,220.00
Access doors	188	ea	60.00	11,280.00
Galvanized sheet metal ductwork	8000	lbs	6.75	54,000.00
Ductwork Insulation	3000	sf	2.00	6,000.00
Boiler and water heater flue breeching	1	ls	7,500.00	7,500.00
Hot water piping	3500	lf	25.00	87,500.00
Condenser water piping	2800	lf	20.00	56,000.00
Drain piping	500	lf	15.00	7,500.00
RTU hook-up	13	ea	15,000.00	195,000.00
Cooling tower balancing	2	ea	100.00	200.00
Boiler balancing	3	ea	150.00	450.00
RTU balancing	13	ea	150.00	1,950.00
Heat pump balancing	188	ea	50.00	9,400.00
Rigging	1	ls	40,000.00	40,000.00
			Total	**$1,068,100.00**

Original System Complete Cost	$2,015,210.00
System Cost of guest suite equipment	$1,068,100.00
Cost of non-suite related system	**$947,110.00**

Figure 1 –Original System Cost

System Advantages and Disadvantages

Advantages:

- High level comfort control
- Quiet operation
- Low operating costs
- More durable

Disadvantages:

- High first cost
- More equipment required
- More difficult to maintain

Redesigned System

System Background

A system of packaged thermal air conditioners, PTAC's, was selected as an alternative mechanical system to the original design. More commonly known as through-wall units, PTAC's involve much less equipment to operate and therefore less labor to install than the hotel's original system.

The use of PTAC's is common in hotel construction for several reasons. First, by having a unit or multiple units in a guest suite, the guest is capable of easily controlling their own comfort. Secondly, if a mechanical failure were to occur the hotel would not lose the ability to rent out several rooms but only one. In the event of a mechanical failure, the hotel could also have backup PTAC units on hand to quickly replace a down unit in order to keep the room rentable.

Carrier's Premier Series 52P, shown above, was selected as the PTAC for the redesign. The Premier Series offers heating and cooling in a single package. The unit features a heat pump and an electric heater. The electric heater is used when outdoor coil temperatures drop below 20° F and the heat pump operates when outdoor coil temperatures are above 20° F. By including a heat pump and an electric heater the Premier Series is more efficient than PTAC's that have only an electric heater. Electric heaters are less efficient than heat pumps and by limiting the need for the electric heater the Carrier Premier Series is more efficient. Operation from heat pump and electric heater is automatically controlled.

The design of the PTAC system was aided by Carrier's Hourly Analysis Program, version 4.2 (HAP). The hotel features three different guest suites: one bedroom with a partition between the sleeping and living area, one bedroom without a wall between the sleeping and living area, and a two bedroom suite with partitions dividing the spaces. Five spaces were modeled in HAP to calculate the heating and cooling loads needed to select a PTAC size. A single unit has been selected for all spaces. The demands fit within this units operating range, therefore the unit is not either over or undersized. The model selection chart is shown in Figure 2 below with the selected model highlighted.

PERFORMANCE AND ELECTRICAL DATA
MODEL 52PQ (265-1-60)

MODEL NUMBER 52PQ	CAPACITY* (Btuh)			HEATER kW	EER	COP†	VOLTAGE RANGE	AMPS		WATTS	
	Cooling	Heating						Cooling	Heating**	Cooling	Heating
		Rev. Cycle	Electric								
207---4	7,200	6,300	7,800	2.3	12.3	3.4		2.4	9.2	585	2396
307---4	7,200	6,300	11,600	3.4	12.3	3.4		2.4	13.3	585	3496
209---4	9,100	7,700	7,800	2.3	11.5	3.2		3.1	9.2	791	2396
309---4	9,100	7,700	11,600	3.4	11.5	3.2		3.1	13.3	791	3496
212---4	12,100	10,800	7,800	2.3	11.1	3.2		4.2	9.4	1090	2470
312---4	12,100	10,800	11,600	3.4	11.1	3.2	239-292	4.2	13.5	1090	3570
512---4	12,100	10,800	17,000	5.0	11.1	3.2		4.2	19.6	1090	5170
215---4	14,700	14,100	7,800	2.3	9.7	3.0		5.7	9.4	1515	2470
315---4	14,700	14,100	11,600	3.4	9.7	3.0		5.7	13.5	1515	3570
515---4	14,700	14,100	17,000	5.0	9.7	3.0		5.7	19.6	1515	5170

MODEL NUMBER 52PQ	POWER FACTOR %	FAN MOTOR			MAX. FUSE SIZE (Amps)	MIN. CIRCUIT AMPS	RECEPTACLE TYPE††	R-22 CHARGE (oz)	DEHUMIDIFICATION (Pints/Hr)	SENSIBLE HEAT FACTOR	APPROX. CHASSIS SHIP WT (lb)
		Horsepower	Full Load Amps	Indoor CFM LO/HI							
207---4	97	0.075	0.46	220/260	15	11.3	A	26	1.5	0.78	125
307---4					20	16.5	B				
209---4	97	0.075	0.46	220/260	15	11.3	A	24	2.4	0.73	125
309---4					20	16.5	B				
212---4	99	0.125	0.71	270/340	15	11.6	A	34	3.4	0.71	140
312---4					20	16.7	B				
512---4					25	24.3	C				
215---4	96	0.125	0.71	250/320	15	11.9	A	33	4.6	0.67	150
315---4					20	17.0	B				
515---4					25	24.6	C				

Figure 2 –PTAC Unit Selection Chart

System Equipment Cost

The estimate for the PTAC was performed by looking up unit prices online and applying installation costs and other construction related costs such as overhead and profit. The original system included 188 units; however the PTAC system requires a unit for each room within the guest suites.

Item	Qty.	Unit	Unit Cost	Cost
Packaged thermal air conditioners	269	ea	1,300.00	349,700.00
Electrical hookup	269	ea	60.00	16,140.00
Air filters	269	ea	15.00	4,035.00
Optional thermostats	269	ea	100.00	26,900.00
Architectural Louvers	269	ea	350.00	94,150.00
			Total	**$490,925.00**

Non-suite related system cost from original design	$947,110.00
Total system cost	$1,438,035.00
First cost system savings	**$577,175.00**

Figure 3 –PTAC System Cost

System Advantages and Disadvantages

Advantages:

- More flexible/lower design cost
- Lower mechanical failure impacts
- Much less equipment required
- Lower upfront cost

Disadvantages:

- Lack of ducting lowers quality of distribution
- Affects architectural design of exterior: louvers
- Higher operating costs
- Higher noise operation level

Conclusions and Recommendation

Conclusions

A point by point list of conclusions:

- The PTAC system has a considerably lower first cost than the original design.
- Although cheaper than the original design, the PTAC system is a lower quality system in that the controllability and comfort level in the rooms is lower than the original design. The PTAC system also operates at a higher decibel level than the heat pump system.
- The PTAC system would significantly change the appearance of the exterior architecture of the hotel by adding louvers at the location of each unit.

Recommendation

- The owner of the Residence Inn has the desire to lower the first cost of the building. Presented here was one way to lower the first cost. However, by changing to PTAC's the quality of the mechanical system is lowered and the architecture of the building is negatively impacted. Over the life cycle of the building, PTAC's will cost more than the original design. Therefore, it is recommended that the owner not change the mechanical system of the Residence Inn and in turn find another way to lower the first cost of the building.