ENERGY SAVINGS ANALYSIS

Building	Estimated	Actual
Flow reduction	4,840 cfm	4,695 cfm
Gas savings	9,908 therms	9,611 therms
Electric savings	7,000 kWh	7,244 kWh
Cost savings	$7,070	$6,899

Annual per unit savings	
Gas (NG)	31 therms
Electric	36 kWh
Cost	$30/unit

*** Based upon $0.65/therm and $0.09/kWh**

Investment analysis	
Simple payback	~ 2 months
Savings to investment ration (SIR)	62
Internal rate of return**	620%

**** Based upon motor lifespan of 10 years**

Figure 8: Test and balance contractor measuring airflow before and after fan turn down.

Positive outcome extending beyond energy savings

We conducted a survey of the occupants three weeks after the retrofit was completed and found that over 98% of respondents replied neutrally or favorably to the change. Further, a survey of the building management team indicated that the retrofit had little impact on building operations and was viewed as a positive change to the building systems. Significant energy impacts were achieved while maintaining occupant comfort and good indoor air quality. The building management team also provided positive remarks saying that the process did not take "too much" of their time and that no residents complained about the change.

MINNESOTA DEPARTMENT OF COMMERCE
DIVISION OF ENERGY RESOURCES

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VENTILATION RETROFIT CASE STUDY
REDUCING SUPPLY VENTILATION FLOW

BUILDING CHARACTERISTICS

- 24 story residential high-rise for seniors
- Located in South Minneapolis
- Built in 1970
- Natural gas fired steam boiler heat, 80% efficient
- Central cooling only in common areas, window A/C units in apartments
- 193 apartment units with large community areas on floors 1 and 23 and small lounge areas throughout
- Mix of studio, one bedroom and two bedroom apartments

VENTILATION SYSTEM

This building has both a central supply and a central exhaust ventilation system.

SUPPLY SYSTEM. Outdoor air is continuously supplied to the corridors on floors 2 through 22 by an air handling unit that is located in the basement (Figure 1). It draws 100% fresh air, with no recirculated air. The outdoor air intake for this air handling unit is an 84 x 108 inch grille located at the rear wall of the first floor exterior (Figure 2). It draws in outdoor air and filters, conditions and distributes it through a common vertical shaft to a single register on each floor (Figure 3). The typical hallway layout for the building is shown in Figure 4. A second air handling unit supplies outdoor air mixed with return air for the main floor and basement community areas. A third air handling unit located in the penthouse serves the community area on the 23rd floor. The building is conditioned with steam boilers in winter and individual apartment unit window A/C cooling during summer. Each air handling unit has a heat exchange coil from the boilers to condition outside air. For this study, only the corridor air handling unit was evaluated. The air handling units serving the common areas on the 1st and 23rd floors were not within the scope of this study and are not discussed in this case study.

Figure 1: Corridor supply air handling unit

Figure 2: Air intake for corridor air handling unit

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EXHAUST SYSTEM. Exhaust air is continuously drawn from apartment unit bathrooms. Each bath inlet is ducted into one of ten exhaust shafts that meet in a penthouse mechanical room. A central fan in the penthouse exhausts the air to the exterior through a large grille on the penthouse wall. No energy saving recommendations were made for this system as it was evaluated and found to be operating within 10% of the code required flow for the building. However, sample measurements taken throughout the building found that some balancing louvers were maladjusted or clogged, causing high or low flow rates, so we recommended modifying the inlets to effectively balance the ventilation exhaust distribution. Though this is not an energy-saving measure, this can be a way to prevent odor complaints and reduce indoor humidity, which both can lead to significant maintenance costs if left unaddressed.

Figure 3: Corridor registers. Left: A single 8”x80” register supplies make up supply air to each floor’s corridor. Right: The balancing damper behind the register grille provides airflow adjustment.

FINDINGS

We measured the total outdoor air intake airflow of corridor supply using a blower door, masked to cover the entire intake opening and adjusted to measure flow while matching the existing duct pressure (Figure 5). We found that reducing the supply ventilation flow rates could achieve significant energy savings with paybacks well under one year.

Local code officials require a corridor make up airflow rate of 6,905 cubic feet per minute (cfm) to match apartment exhaust airflow (instead of the ASHRAE 62.1 requirement of 852 cfm). The air handler was providing 11,745 cfm of make up air, 70% more outdoor air than is required.

At the time of the assessment the heat exchange coil downstream of the filters was loaded with dust (Figure 6). While the filter was clean, the access door for the filters had a broken hinge which was allowing air to bypass the filters and move directly into the heat exchange coil without dust filtration. This clogged up the coil and restricted airflow. Since the initial airflow measurement number would change once the coil was cleaned, we recommended another airflow measurement be taken after the coil was cleaned, but before it was adjusted to reduce flow. With the clogged coil, the airflow was 3,700 cfm above the flow requirement. After the coil was cleaned, the airflow rate increased 1,100 cfm, which was 4,800 cfm above the flow requirement

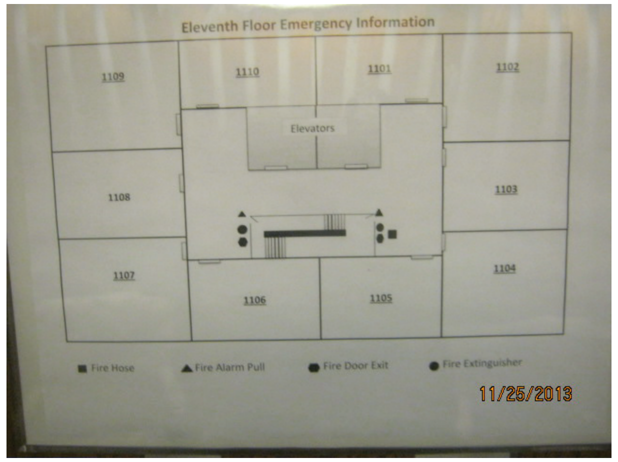

Figure 4: Fire escape plan posted in the hallway shows typical floor layout. There are 10 units per floor around the perimeter of the building and minimal corridor area in the center of the building. One supply register provides 100% outdoor air to make up for air exhausted from apartment units.

Our building analysts also measured motor power use and rotations per minute (RPM). Measured power use for the fan was 20,708 kWh per year. Reducing the fan speed would decrease its measured power use and, based on turndown ratio, we projected a 35% reduction in power use.

WORK SCOPE

There were two options for reducing flow on the corridor air handling unit. The first option was to re-sheave, or change the pulley size on the existing fan, to reduce fan RPM. A second option was to add a variable frequency drive (VFD) to the fan to equip fan turndown. Figure 7 shows the fan motor and pulleys. Adding a VFD to the fan had higher upfront costs and, though it could be fine-tuned to accurately meet desired flow rates, the digital control is easy to tamper with and flow can be altered with the turn of a dial. VFD controls are also not compatible with all motors. Compared to the fluid adjustment capability of the VFD, re-sheaving would achieve tiered changes to RPM and would have a broader margin of error for achieving targeted flows. However, re-sheaving is a low cost, permanent change to the fan RPM that is widely accepted in the industry. For these reasons we chose to re-sheave the existing fan.

Serving as owner’s representatives for the property, we wrote a work scope describing the adjustment and desired outcome and obtained bids for the work from three Test and Balance (TAB) crews. The bids ranged from $1,200 to $2,746 and the low bid was selected. The work scope was to re-sheave the corridor fan and confirm airflow within +/- 10% of the required flow (ASHRAE 62.1-2007, Section 8.4.1.8, specifies +/- 10% balancing tolerance). This would pay back in 2 months. The work scope did not include balancing distribution to all registers, but if included, paybacks would still have been less than 6 months. Figure 8 shows the TAB contractor measuring make up airflow by completing a duct traverse.

Figure 5: Airflow measurement. Crew used a calibrated fan to measure outdoor air intake airflow.

Figure 6: Dirty heat exchange coil restricted airflow. Air was bypassing the filters (right side) because of a broken hinge on the filter access door and dust was accumulating in the heating coil in the air handler, affecting heating efficiency and restricting airflow.

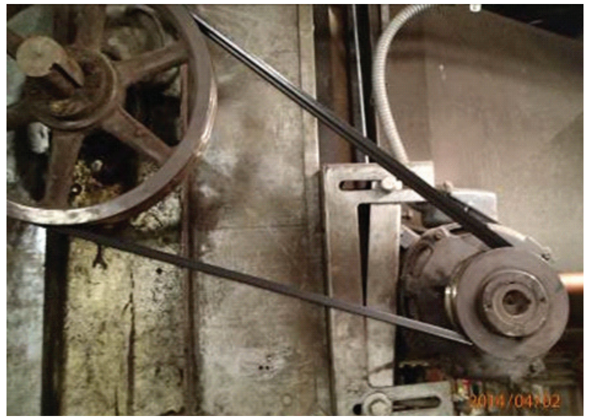

Figure 7: Corridoor fan pulleys.

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