Office

Transamerica Pyramid ***Case Study***

New ventilation system is efficient, redundant, quiet — and tenants undisturbed by demolition/ re-construction

As integral to the San Francisco skyline as the Golden Gate Bridge and the Coit Tower, the Transamerica Pyramid has been recognized as an avant-garde building since the first cornerstone was laid in 1969. The iconic pyramid-shaped building, owned by AEGON since 1999, is the most recognizable within the larger Pyramid Center complex that encompasses an entire city block in the Financial District. Architects William Pereira & Associates chose the pyramid shape not just for its unusual look but also to meet a specific need: a pyramid casts a smaller shadow than a conventional high-rise building, allowing more light to filter to the streets below. At the time, that met the requirements of a special "shadow ordinance" in this foggy city on the bay. The building's cutting-edge tradition continues today: upgrades and retrofits have earned a LEED® Gold certification for the Transamerica Pyramid. And a recent upgrade to one section of the building's HVAC system is equally inventive.

The aging air-handler fans serving floors one to 18 of the building required continual maintenance because of their age. Building management sought a replacement that would cause minimal disruption to tenants, simplify and reduce costs for installation in the existing mechanical space and contribute to energy efficiency and redundant operation.

Replacing the old housed fan with a new one was quickly ruled out. It would have required extensive demolition and reconstruction and disrupted tenants. Instead, AEGON opted to replace the old fan with FANWALL TECHNOLOGY®, a modular fan system introduced in 2004 by Huntair, Inc., a CES Group company. The multiple fans generate the 202,000 cfm required, but the modular design allows individual fan cubes to be navigated through the building and 3-foot doorways and stacked in place. The resulting system is more energy-efficient and quieter than the existing huge fan, while also providing redundancy.

At a Glance

- Aging air handler fans serving floors 1 to 18 were beyond their service life, requiring continual maintenance.
- Goals of replacement included using the same space, minimum disruption to tenants, lower maintenance, better efficiency and redundancy.
- Modular fan system using FANWALL TECHNOLOGY met all goals while allowing additional system changes to better improve performance.
- Retrofit completed on weekends with little or no interruption to normal operations.
- Tenants and building management now benefit from a much quieter system, redundancy to avoid downtime and a savings of 80,000 kWh in energy consumption that resulted in an $11,000 rebate from Pacific Gas & Electric

"We looked at FANWALL TECHNOLOGY as a way to upgrade the system without having to bring in a whole lot of demolition equipment," said Dennis Latta, construction manager for the Pyramid Center. "It was a good option because we could redesign the layout of the cooling coils, fan intake and ducting at the same time."

High probability of catastrophic fan failure

At 853 feet (260 meters) high, with 48 stories and 500,000 square feet of floor space, the Transamerica Pyramid requires multiple air-handling systems to serve the various zones of the building. Two mechanical rooms on the fifth floor serve two separate systems—a north side and south side—on floors one through 18. Each mechanical room has its own air-handling system, including fan, chilled water coils and filters and generates 101,000 cfm. The original, behemoth fans in each mechanical room were the primary problem. About the size and weight of a Volkswagen Beetle, the housed squirrel-cage design posed an obstacle on several fronts, including demolition, replacement and efficiency.

Besides the fans, each air handler dated to the early 1970s and had outlived its recommended lifespan. Some of the cooling coil drip pans were leaking, which posed potential corrosion problems and air quality issues. The likelihood of a catastrophic fan failure was high. Although spare fans and motors were available, delivery lead times were long. Replacing the fans and coils at the same time would save a considerable amount of labor and costs—but a like-for-like replacement of the fan would result in as much as two, three or even more weeks of downtime which was not an option in this busy facility.

Renovation without tenant disruption

AEGON wanted to avoid disrupting tenants while keeping costs within budget. Installing a new housed fan would mean demolishing walls, expensive rigging costs to bring the fan in with a crane, plus long lead times and disruption to building comfort.

In addition, the mechanical room was a small space, with little room for staging or equipment lay-down. The project would have spilled into the hallways, posing additional tenant disruptions.

Besides managing the logistics of the retrofit itself, additional goals were efficiency and redundancy. Gaining redundancy was important, not only to ensure uninterrupted building comfort, but also because the fan system serves a 24/7 data center. "The FANWALL TECHNOLOGY concept gave us a lot of avenues to help alleviate the challenges we faced," said Doug Peterson, chief engineer for the Pyramid Center. "Plus, I wanted to avoid a like-for-like retrofit because of the negative affects on tenants. To do everything we did without interrupting tenants was a real bonus."

FANWALL® system provides redundancy

Fortunately, there was a simple solution that met all requirements. Shaun Webster, sales engineer with Norman Wright, the local manufacturers' representative firm for Huntair, had presented the modular-fan concept to a group of 180 chief engineers in the San Francisco area. None had ever heard of the system. Webster contacted Pyramid Center management to discuss the concept as a viable solution.

FANWALL TECHNOLOGY provides multiple, direct-drive fans and motors in place of a single motor and fan. The multiple fans and motors provide redundancy in the event of a fan or motor failure because the remaining operating fans and motors continue to deliver airflow—and the smaller size and weight of the motors makes replacement easier. "FANWALL TECHNOLOGY changes a fan failure from a catastrophic event to a routine maintenance item," said Webster.

The differences between FANWALL TECHNOLOGY and the existing fans in this case are startling: multiple cubes of direct drive plenum fans arranged in a "wall" or bank replace the large, forward-curved squirrel-cage fan in each of the two air-handling units in the fifth floor mechanical room. Each FANWALL cube weighs about 600 pounds total and includes a motor and fan. The entire system is custom-configured by selecting the number of fans, wheel diameter, and rpm to add up to the same cfm as the original fan. In the fifth floor mechanical room, two separate banks of 15 fans supply air and require less energy: combined, they require 300 hp instead of the 400 hp required by the older system.

The return fans shown above are reminiscent of the supply fans that were replaced - each the size and weight of a Volkswagon Beetle.

Fan cubes easy to install in limited space

From the early stages of the project, Randy Scott, senior vice president, Critical Facilities Group, Skyline Construction, credits HUNTAIR with being an active participant in the project. "Right from the start of the project, Norman S. Wright and HUNTAIR were involved in the project and part of the team working with us on the complex logistics associated with the FANWALL implementation," said Scott. That included a tour of the factory in Tualatin, OR, as well as pre-planning, installation, implementation and follow-up.

Two of the primary challenges for the demolition and construction were to maneuver and install the new fan system, coils and associated piping in the confined space of the mechanical room, and to do the retrofit project in stages on weekends so tenants would not be inconvenienced.

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Replacing the fans, coils and filters provided the most economical and desirable outcome for the project. Close coordination between construction management, engineers, contractors and Huntair representatives, resulted in the project being completed over weekends with little or no downtime or tenant disruption.

"The design challenge I had was to find a space for the new fan system, upstream or downstream from the old fan, so we could get it all set up ahead of time, and then determine the geometry of the space," said John A. Oldham, P.E., principal of Oldham Engineering, Inc., the mechanical firm for the project. Oldham Engineering has worked on other mechanical engineering projects in the building for the last 10 years. "We had some difficult space to design in, and everything had to be measured ahead of time to the nearest inch—including height, width, conduit, pipes—so we knew everything would fit. We had the added advantage of being able to eliminate sound-traps altogether, because the fans operate so quietly. That opened up another five feet on either side of the old fan." In fact, the entire FANLWALL® system only requires about five feet of space. That means all preparations could be completed while the old fan remained operational, virtually eliminating downtime for tenants.

Oldham had another priority as well. "I really wanted to get more static pressure into the space and make the whole system run a lot better. The building has had overheating problems since it was built. Before we found FANWALL TECHNOLOGY, we couldn't fix that. We couldn't change out the fans because they were buried too deep in the building, and the building couldn't be down as long as it would take to replace them. With FANWALL TECHNOLOGY, the ventilation conditions are a lot better, and we're saving a lot of energy."

The demolition and re-construction work, completed in three weekends per side, was the responsibility of Kevin Frederick, project manager for the mechanical contractor firm, Anderson, Rowe and Buckley, Inc., San Francisco. Oldham had found enough space downstream from the original fan, and that's where new construction occurred.

"Over the first weekend, we installed and commissioned the news coils, leaving the old fan in place with new coils," said Frederick. On the second weekend, the old fan was removed, and Frederick's team installed the new FANWALL cubes. The old fan measured 12 x 12 feet and included a 1900-pound motor and concrete base. It was removed between 6 PM Friday and 6 AM Saturday.

Once the old fan was removed, "installing the FANWALL system itself was just a matter of getting the cubes in place, bolting them down, assembling and flashing off to the existing plenum and the new plenum area and commissioning," said Frederick. "It was the easiest part of the project. We laid out the cubes on the floor and sequenced everything in the proper order to fit in the plenum correctly. It went together very simply."

Independent Acoustics and Vibration Study Shows Superior FANWALL System Performance

Huntair commissioned Charles M. Saltar Associates, Inc. to perform an independent study of the before and after acoustics and vibration characteristics of the Transamerica Pyramid replacement project.

Working with the building's engineering team and equipment vendor, locations on the fifth (mechanical room) and sixth floor were chosen to represent locations typically occupied by tenants, engineers, contractors. In multiple site visits during the removal of the supply fans and replacement with the FANWALL systems, noise and vibration levels were measured at various spaces. Additional acoustical measurements were conducted near the exterior louvers to estimate potential reductions in noise transfer to neighbors and exterior locations.

Measurements were typically taken in the very early morning, prior to the arrival of tenants, to reduce the potential for extraneous noise sources affecting our measurements. Airflow rates, rotational speed, and drive frequency were monitored and programmed for the existing supply fans and the FANWALL systems to maintain consistency for acoustical measurement comparison.

Results from the study demonstrate that incorporating the FANWALL system has dramatically reduced noise and vibration levels:

- At locations where supply air equipment dominated the noise environment, levels were reduced between 7 dBA and 13 dBA (8 dB and 17 dB overall) and 15 to 20 NC points. For reference purposes, a reduction of 10 dBA would be perceived as an approximate halving in loudness.
- Vibration velocity levels at the building structure were reduced between 5 dB and 8 dB re 9.8×10^{-12} m/sec^2.

On the third weekend, the existing coils and filter bank were removed and the new filter bank installed.The sequence was the same for the second mechanical room. The entire demolition and re-construction was completed in six weekends, three weekends per side.

"Given the complexity and dynamics of the project, I'd do it exactly the same way with the same players involved if I had to do it all over again," said Chief Engineer Peterson. "It was that much of a home run."

Results: Less noise and vibration; reduced kWh

Initial concerns for General Contractor Scott included both sound and vibration, but those concerns abated soon after installation. "You can put your hand on the FANWALL® system and there's no vibration. You can have a normal conversation and hardly even know the fans are operating. That's positive given that there are tenants on the floors above and below and a data center next door." The reduced sound and vibration was also verified through an independent study commissioned by Huntair (see sidebar, page 3).

The operating characteristics of the FANWALL system have proven that it is much more efficient than the single DWDI fan that was replaced in this system. FANWALL TECHNOLOGY® produces a uniform piston of air, creating a uniform velocity profile at the unit coils and filters and throughout the airway path in the unit. This uniform airflow profile reduces static pressure drop due to turbulence and system effects. As a result, the FANWALL system draws between 60 and 70 amps less compared to the existing system. Actual results show that the Transamerica Pyramid reduced electrical consumption by 80,000 kWh, or $25,000 during the first year of operation. Because of the energy savings, the local utility, Pacific Gas and Electric, contributed a rebate incentive of over $11,000.

Selecting the critical factors of fan efficiency (number of fans, wheel diameter, blade width and rpm) provides close to peak efficiency of the fan curve, according to Norman Wright's Webster. Efficiency is further optimized because the brake horsepower required is close to connected horsepower and the overall "system effect" is reduced. The uniform piston of air across the filters reduces pressure drop and increases airflow efficiency. Plus, no sound attenuation was required, eliminating that static pressure penalty.

Tangible differences go beyond performance

All of these factors are good news for Latta, whose focus as construction manager is energy savings. "The landlord, AEGON, has been supportive in a number of energy-saving projects. We're an official green building now and want to keep that philosophy going forward. The new fan system supports that philosophy."

"One of the things that's really exciting about this project is that it's 21st century technology," he added. "FANWALL TECHNOLOGY has been available since 2004, and we have the latest version. Personally, projects that excite me are those that make something better, and this retrofit certainly falls into that category. It's common to remove something and replace it with similar equipment. This project is much more than that. It's easy to see the difference between the fifth floor mechanical room and the other three mechanical rooms in the building. The fifth floor is quieter, more spacious, and the multiple array of fans makes it easy to understand why it's unlikely we'll have a major disruption to cooling on floors one through 18."

Retrofit vs. Replacement

For air handlers that are reaching the end of their service life, replacing existing fans and other components can be the most cost-effective solution for avoiding the cost and business disruption of an air handler failure. Access limitations are a barrier to many replacements because they cannot be accomplished without the time and expense of a major tear-out and reconstruction project. FANWALL systems can minimize these and other barriers.

- An air handler cabinet can retain its integrity well beyond fans, coils and other components, allowing it to be retained.
- The modular design of FANWALL systems allows individual cubes to be navigated through a standard 3-foot door and assembled inside the existing air handler cabinet.
- There is no need to have a crane on site as is often the case with larger conventional fans.
- The performance of the new system can be upgraded to better match actual capacity and airflow requirements.
- Ancillary components such as sound attenuators and air blenders that created static pressure penalties in the old system can be removed.
- Design flaws and other maintenance concerns – such as component access issues and corrosion – can also be addressed, essentially resulting in a new, more efficient air handler in an old skin.
- All of this often can occur over a weekend or during unoccupied time frames to minimize downtime or disruption of normal business.

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