

ENGINEERING
TOMORROW



Case story | VLT® Drives

Engineering
Tomorrow
Reduces Multi-Use
Building's **Energy
Consumption** and Aids
in **Demand Response**
Programs

\$1.1M

saved on energy
costs after the
installation of
Danfoss VLT® Drives.

In 1970, the U.S. Steel Corporation built a unique headquarters that still stands 64 stories above the Pittsburgh, Pa., skyline. Built to last 100 years, the skyscraper now known as the U.S. Steel Tower is architecturally unique. It features a distinctive triangular footprint using U.S. Steel-developed COR-TEN® steel to form an external girding system that allows each story to contain an acre of floor space. While ahead of its time in the 1970s, the building fell behind with mechanical equipment that was installed when kilowatts cost pennies and oil was \$3 per barrel. That's why Winthrop Management, the building's property manager, began a series of retrofits using Danfoss variable frequency drives (VFDs) to cut energy costs – resulting in over \$1 million in energy savings and a greener reputation that's attracting tenants.

"We have been applying Danfoss VLT® Drives in various retrofit projects for nearly 15 years," says Gary Sechler, engineering manager for Winthrop Management. "After every retrofit project phase, we've found the energy savings on pump motors and fans have been outstanding. So we would embark on another phase. As it stands now, we've installed more than 150 VLT® Drives – with more to come."

Danfoss drives meet retrofit challenges

The 64-story, 841-foot (256.34 m) U.S. Steel Tower, once known as the USX Tower, provides more than 2.3 million square feet of leasable space in downtown Pittsburgh. It is the city's tallest skyscraper and one of the highest commercial buildings between Chicago and Philadelphia – with major tenants including U.S. Steel and the University of Pittsburgh Medical Center (UPMC), which occupies 40 percent of the space.

"We're moving a lot of water and air up, down, and around this building," says Sechler. "Water is supplied by two redundant water mains. In addition, there are four redundant, 100-HP water pumps in the building. Each one can serve the entire building, if needed. There are also two boilers on the sixty-fourth floor and three centrifugal chillers on the sixty-third floor to provide redundant heating and cooling. So there is a lot of pumping needed for domestic water circulation and for the chilled water loops, all of which consume a lot of energy."

The first VFD retrofit project was in the year 2000 when VLT® Drives were applied to four 100-HP pump motor responsible for the building's domestic water supply.

"The old drives were two-step drives like they used in steel mills back in the day," says Jim Rice, owner of M&R Affiliates, the Danfoss sales representative who has been working with Sechler since he has been in charge. "They weren't true variable frequency drives. We replaced them with four Danfoss VLT® HVAC Drives that delivered 100 HP at 460 volts and provided a true soft start."

According to Gary Sechler, the soft start eliminated a lot of wear and tear on the motors – and also saved energy. "We're talking big motors to pump water to a 300-gallon cushioning tank on the sixty-fourth floor. From there, the water feeds down to fountains, sinks, and toilets on the floors below. Only two of the four pumps run at any given time in a lead-lag sequence that alternates weekly. But the old motor speed controls were obsolete and parts were no longer available. I don't have a record of energy savings from that time. But I do know with the soft start on VLT® Drives, pump motor rebuilds have been zero."




Jim Rice, owner of M&R Affiliates, and Gary Sechler, engineering manager for Winthrop Management, check one of the Danfoss VLT® Drives installed in the U.S. Steel Tower.

The next retrofit opportunity presented itself after the state of Pennsylvania passed legislation (PA ACT 129) in November 2008 requiring Electric Distribution Companies to reduce electricity consumption and peak demand. In response, Duquesne Light provided a rebate program for businesses that install variable frequency drives to replace old-style motor speed throttling technology .

"We jumped on this program," says Sechler. "We knew what VLT® Drives did for our house water pumps. So in 2010, we looked at what they could do for our large 200- to 250-HP fan motors. These fans circulate conditioned air in large office areas at a given static pressure to satisfy the temperature setpoint. We ended up applying about 40 more Danfoss drives for motors ranging from 30 HP to 250 HP."

"We were absolutely delighted with the energy savings, because the drives cut electricity costs by \$535,000 annually. And along with those savings, we got rebates that produced a one-year payback. So naturally, we kept looking for more places to apply drives."

Rice explains that the astounding electricity savings are derived from the physics of "affinity laws," which state that reducing the speed of a pump or fan motor reduces power consumption exponentially. For example, applying a VLT®

The background image shows an industrial facility, likely a steel mill, with large VLT HVAC Drive units mounted on metal frames. The units are grey with black control panels featuring digital displays and buttons. The environment includes concrete floors, yellow safety railings, and industrial pipes. A red text box is overlaid on the lower portion of the image.

“Buildings like the U.S. Steel Tower consume 40 percent of all energy used in the U.S. And there’s a lot of opportunity to reduce that use by controlling the motors that don’t need to run at full speed. The U.S. Steel Tower is a great example of what variable frequency drive technology can do.”

- Stanley Aranowski, Regional Sales Manager, Danfoss

Drive that can reduce pump speed by 20 percent results in potential energy savings of up to 50 percent.

In 2011, Sechler embarked on Phase Two of the retrofit project. Once again, the VLT® Drives were applied to pump motors – but this time for the chilled water and pre-heat water loops.

“These pump motors are considerably smaller than those used for the domestic water pumps,” says Sechler. “But there are more of them.” For this project, VLT® Drives were applied to 40 pump motors ranging from 50 HP to 200 HP. And once again, the savings were astounding: annual electric costs were reduced another \$138,000.



More than 150 variable frequency drives have been installed to reduce the energy consumption of various building processes -- from the domestic water supply to fan and pump motors on the chilled water and pre-heat water loops.

In 2012, a Phase Three project added 16 drives for 250-HP motors. Following a three-year extension of PA ACT 129, Phase Four of the project in 2013 applied about 40 VLT® Drives to smaller 7.5- to 60-HP pump and fan motors. After each phase, the electric savings amounted to \$317,000 and \$152,000 a year, respectively.

Results that impact the bottom line and reputation

“In 2009, our electric consumption averaged 65 million kilowatts hours,” says Sechler. “Now it’s down to 43 million kilowatts. Our peak demand was 16 to 17 megawatts; now it’s 10 megawatts. This is a huge savings that goes right to the bottom line. Altogether, nearly 150 Danfoss VLT® Drives

are producing more than \$1.1 million in documented annual energy savings. Plus, improved energy efficiency makes the property more attractive to tenants. We’ve been up to 98 percent occupancy, which is really great in today’s commercial real estate market.”

To manage the installation, each drive incorporates Apogee® FLN as a software-selectable communications protocol that connects with the building automation system (BAS). The pump drives are controlled via an in-house Direct Digital Control, which measures pressure differential across the pump to regulate drive speed. The BAS logs drive performance data and energy consumption, including drive condition. Sechler’s in-house engineering team is also able to track operational status – and they are delighted that there has been practically no drive downtime since the first one was installed 15 years ago.

According to Danfoss Sales Manager Stanley Aranowski, the continuing success of the retrofits is also a credit to SSI, Inc., Danfoss’ service partner based in nearby Cranberry Township, Pa. “SSI has been used for all start-ups and for on-call service that makes a project like this problem free. Their support and expertise is the secret to ensuring a successful VFD project like this.”

Sechler also notes that the energy savings from the VLT® Drives are helping give the building a greener reputation. UPMC qualified 17 of the floors it occupies for silver LEED® certification and six for gold LEED® certification through the services of evolveEA, a sustainable architecture and consulting firm. In addition, Winthrop Management signed the U.S. Steel Tower onto the Green Building Alliance 2030 District Challenge – a public-private partnership for the downtown Pittsburgh building district, which commits the U.S. Steel Tower to reducing energy usage 50 percent by 2030. In April 2015, the building also received designation through the BOMA 360 Performance Program for excellence in operations and management, including energy use and energy management.

“Thanks to Danfoss VLT® Drives, we’ve already cut energy usage by 34 percent,” Sechler says enthusiastically. “Jim Rice and SSI have worked closely with us year after year to phase in the installation flawlessly. Combine the energy savings, robust quality, and rebates that reduce paybacks to less than one year, I couldn’t be happier. Plus, the tenants are happy, and the building owners are delighted. Thanks to Danfoss VLT® Drives, the U.S. Steel Tower can stand proudly in Pittsburgh’s skyline for years to come.”

This material may not be republished without prior permission from Danfoss.