

Case Study: Suzhou BSE Air Conditioning Co., Ltd.

HVAC chiller manufacturer uses magnetic-levitation compressors and Opto 22 controls to deliver energy efficient, reliable, and compact chillers for central air conditioning systems.

Under a quiet overpass in Shanghai there's a dull humming noise in the distance. The noise gets louder as something approaches, moving fast. Suddenly a train stretching five cars long screams overhead at 268 mph (431 kph). Blink once and it's already gone.

This is the Shanghai Maglev Train, also known as the Transrapid, and it's the fastest commuter train currently in operation anywhere in the world. The train line runs 16.6 miles (26.7 km) from Longyang Road station in Pudong to Pudong International Airport and takes a mere 7 minutes and 20 seconds to make the trip. Imagine cutting your commute to the airport in half.

These extreme speeds are possible because the train isn't running on wheels. Instead it's using a technology called *magnetic levitation*. Magnetic levitation (maglev) allows the train to literally float in the air just above the track using an electrically generated magnetic field.

Instead of having wheels that roll on top of a track, powerful magnets lift and guide the train above what's called a guideway, while a non-contact electromagnetic propulsion system moves the vehicle down the track.



Not Just for Trains

With a powerful enough magnet literally anything on earth will levitate, from a drop of water to an ice cube to a train. Maglev is not a new technology—it was invented in 1905—and today has found its way into a variety of new applications, including frictionless active magnetic bearings.

Compressors for HVAC systems have evolved significantly over the past 50 years. Early compressor systems were remarkably similar to modern automobile engines. Both used cylinders, pistons, and connecting rods, which required regular maintenance and careful attention to lubricant levels. Most failures in HVAC compressors could be traced back to a malfunction in the compressor's oil lubrication system. But now a new technology is barreling toward the refrigeration and HVAC industries at locomotive speeds.



At the Shanghai Pudong Holiday Inn, eight older air-cooled screw heat pumps were replaced with five BSE modular chillers. After replacing the older equipment, the hotel reduced its energy use by almost 40%.

Active magnetic bearings represent the long-awaited commercial application of a scientific breakthrough in physics and electronics. The mechanical engineering profession has heralded frictionless, oil-free motors and compressors based on active magnetic bearings since the 1940s. Yet only recently the emergence of nanosecond-fast semiconductors provided the fine-tuned electronic control needed to maintain a motor shaft within microscopic tolerances, and opened the way to these exciting new applications. One important application for these bearings is in chillers for HVAC systems.

A maglev chiller uses a centrifugal compressor with active magnetic bearings that suspend the compressor shaft in the air so there is absolutely no mechanical contact between the shaft and the compressor housing.

Maglev chillers offer great benefits over traditional screw-type chillers. Because the maglev chiller's shaft and compressor turbine spin suspended and centered in an electromagnetic field, there is no friction, no wear on surfaces, and no oil contamination of the unit's heat exchange surfaces. The chiller's oil-free design eliminates oil maintenance, its costs, and the environmental damage caused by oil use and disposal. And a maglev chiller offers substantial savings in power consumption, drawing a substantially lower starting current (<2 amps), or less than a conventional room air conditioner.

The Problem

The 12th Five-Year Plan (FYP) adopted by the Chinese government in March 2011 devoted considerable attention to energy and climate change and established a new set of environmental targets and policies for 2011–2015. While some targets were largely in line with the status quo, other aspects of the plan represented more dramatic moves to reduce fossil-fuel consumption and promote low-carbon energy sources.

In August 2012, Shanghai was chosen as one of the key cities of the 12th Five Year Plan energy-saving reconstruction program. The city was asked to complete energy-saving reforms of existing public buildings in a 1.5 sq. mi. (3.9 sq. km) area before August 2014. One target of the reconstruction program was to reduce building energy consumption at least 20%.

Opened in 1998, the four-star Shanghai Pudong Holiday Inn includes 34 floors above ground and two floors



BSE's Quest series of maglev chillers also incorporate an Opto 22 control system.

underground, with a total area of almost 580,000 sq. ft. (53,812 sq. m). The original HVAC system of the hotel used eight sets of 200 TR (703 kW) air-cooled screw heat pumps located in the technical room at the top of the 34th floor. These older, less efficient units were close to the end of their service life and were excellent candidates to be upgraded to meet the requirements of the new energy saving reconstruction plan.

Shanghai-based company BSE was chosen to retrofit the hotel's HVAC system. BSE is a pioneer in the maglev chiller industry and uses the SNAP PAC System from Opto 22 to automate, monitor, and control their chiller systems.

The Solution

For the retrofit, BSE implemented its Energy Loop® chiller plant group control system. The Energy Loop system is a complete solution that integrates and automates the entire chiller plant by monitoring and controlling the temperature, flow, and pressure of water-cooled chillers, cooling pumps, condenser pumps, and cooling towers.

BSE replaced the legacy chiller system with five BMMW-0525 BSE modular chillers, each using one Danfoss Turbocor oil-free compressor. After replacing the legacy HVAC equipment with BSE's chiller system, the hotel saw an immediate 39% reduction in energy consumption.

BSE selected Opto 22's SNAP PAC System for the control system, primarily for its superior flexibility and advanced

communication and protocol support, plus Opto 22's *groov* mobile interface system.

Traditionally, chiller systems are managed through a direct digital control (DDC) system that communicates to a supervisory industrial PC or traditional PLC. But BSE's advanced maglev chillers have more points of control than a traditional DDC and PLC system can support.

"In PLC ladder-logic programming, it's difficult to change a single variable or I/O point without that change affecting many other points in the chiller control system," says Zha York, General Manager of BSE.

Using Opto 22's PAC Control flowchart-based development software, BSE engineers broke the control programming down into separate functions called control charts. Each chart handles a different function of the control application. For example, one chart monitors a specific valve, and another chart monitors a specific compressor in the chiller system. In this way, individual control charts can operate autonomously or based on input and output from other charts. A supervisory chart then runs in parallel with the other charts to optimize the system.

Individual I/O points and variables in each chart can easily be modified to work with other chiller types with different numbers of components, without having to change other charts in the overall control program.

"Opto 22 is a very flexible system for integrating equipment from different manufacturers to build out chiller plants," says Zha.

Zha has been working with Opto 22 products since 1999, and over that time he's never received a defective product from Opto 22. "Quality, reliability, and long product life cycle were key points we considered when selecting a control system vendor," says Zha. "Opto 22 met or exceeded all our expectations for a rugged, industrial grade product that we knew we could count on to be available for many years to come.

"We considered other control system providers including Delta V but determined their system was not flexible enough to efficiently integrate other HVAC systems. We also considered designing a system based on a Beckhoff PLC and DDC. But after evaluating the PLC we determined that solution was designed more for machining systems and was not flexible enough for our target applications."

Continues Zha, "Programming in Opto 22's PAC Control software didn't require prior knowledge of the C programming language to automate our chiller systems.

As long as we knew what our application needed from a control perspective, the function block programming style in PAC Control allowed us to quickly convert our proposed control strategy into the physical world and control our system. PAC Control also offered us easy-to-use debugging tools that significantly reduced our engineering and development time."

BSE chillers are installed in a wide variety of applications including data centers, hotels, industrial refrigeration centers, and many others. Each chiller system BSE develops is designed to take advantage of existing HVAC equipment as much as possible. The SNAP PAC controller BSE chose provided an easy communication path between existing HVAC equipment and the new maglev chillers. Each SNAP PAC controller supports Modbus serial and TCP as

well as BACnet MS/TP and BACnet IP.

BSE also leverages Opto 22's *groov* system to rapidly develop custom operator interfaces for their customers' chiller plant management. Each refrigeration and cooling system is different, making the interface to control it different as well. Using *groov's* drag-and-drop, point-and-click method of building a mobile operator interface, BSE can give each customer an interface designed specifically for their chiller plant, without having to write and debug code.



A BSE technician adjusts an Opto 22 SNAP PAC control system in a maglev chiller.



The BSE Energy Loop® Group Control System incorporates maglev chillers, cooling pumps, condenser pumps, and cooling towers in an automated and energy-saving central control system.

About BSE

Suzhou BSE Air Conditioning Co., Ltd. was established in July 2010 with a commitment to develop and produce high-end industrial HVAC systems. BSE is the leading maglev chiller manufacturer in China, and the only Chinese high-tech company that focuses on maglev chiller technology. BSE has developed diverse and groundbreaking products based on this technology, including a modular chiller with 150 RT cooling capacity that weighs 1 ton and has a small 1 sq. m footprint. BSE maglev chillers are widely used in hospitals, schools, commercial buildings, and subways, and have been installed in the Shanghai Xijiao State Guest Hotel as well as the Pudong Holiday Inn. As the leading maglev chiller manufacturer in China and as a manufacturer of high-efficiency air conditioners, BSE believes in saving energy by building innovative, energy-efficient products for use in a variety of applications.
<http://www.bse.com.cn>

About Opto 22

Opto 22 develops and manufactures hardware and software for applications involving industrial automation and control, energy management, remote monitoring, and data acquisition. Designed and made in the U.S.A., Opto 22 products have an established reputation worldwide for ease-of-use, innovation, quality, and reliability. Opto 22 products, including the *groov* mobile operator interface, use standard, commercially available networking and computer technologies, and are used by automation end-users, OEMs, and information technology and operations personnel in over 10,000 installations worldwide. The company was founded in 1974 and is privately held in Temecula, California, U.S.A. Opto 22 products are available through a global network of distributors and system integrators. For more information, contact Opto 22 headquarters at +1-951-695-3000 or visit www.opto22.com.



BSE I-Chiller series chiller units demonstrate the compact dimensions and small footprint that maglev-based compressors make possible.