

# Office and Manufacturing Facility, Energy Efficiency through Automation



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As demand for increased energy efficiency and modernization has ramped up in the HVACR industry, manufacturers of HVACR equipment or components must also expand their capacity to keep up with that demand. While having outgrown their existing manufacturing facilities, the new 270,000 square foot ABB variable frequency drives (VFDs) factory in New Berlin, WI looked to increase production output through improving manufacturing efficiency. This brand new facility includes advancements on the production floor in automation with smart-tools and robotics, as well as office space, training rooms, and research labs. With this variety of building environments, the design of the HVACR system focuses on many aspects used to reduce energy consumption and maintain occupant comfort.

## Building Construction and HVACR System

The previous office space and factory were used to showcase various HVACR equipment and drives controlled with a building automation system over BACnet. The decision was made to invest in a new facility and location that could accommodate current demands and be capable of supporting future growth. The new facility is also meant to be a showcase for HVACR equipment, operations and integration, so presentation and open access to visitors was at the forefront of the system layout.

With new construction comes innovative opportunities as well as overcoming challenges. The

building started as a common, tilt-up construction style warehouse. After the shell was complete, phase 1 started with the 2-story office area, training rooms and lab spaces built inside. Phase 2 was primarily the production and manufacturing space in the same shell building as well as connecting to an adjacent warehouse. Finally, phase 3 included research and development testing labs, services and medium voltage manufacturing all within the same structure.

The office space includes a separate HVACR system from the production and R&D areas. The office space central plant includes the following equipment:

- WaterFurnace 6-pipe, ground-sourced chiller with 150 tons of capacity
- Chilled water, hot water and condenser water loops with N+1 redundant Taco pumps
- Nortek (Ventrol) air handling unit with 12 fan array designed for 60,000 CFM
- Building pressure relief fans with Baldor EC Titanium and Super-E motors
- All fans and pumps are controlled with variable frequency drives, including ACH580, ACH180 and integrated motor drive EC Titanium.

The manufacturing production area has a separate HVACR system from the office area as well as R&D. For the factory space, 12 AAON rooftop units are spread over the area of the building to serve a variety of production lines. Each unit is individually controlled and operating to its own space temperature. All the RTUs are DX cooling coils, 2-stage compressors, electric heat and outdoor air economizing following the

same electrification focus as the office HVACR system.

Finally, the R&D area includes office space as well as labs and testing chambers. The HVACR system in this area is separate but similar to the main office area and uses the same equipment (chiller, AHUs, pumps, RTUs) as the rest of the building but scaled down for the smaller area. This system allows R&D teams to not only have an isolated environment but also to apply and test future releases of both hardware or software in real-world conditions on active equipment.

The 6-pipe chillers are capable of simultaneously cooling and heating by supplying chilled water and hot water to either the air handlers, the VAV boxes for reheat, or to the geothermal field. This 6600-gallon geo-exchange system allows the heat removed from the chilled water to be used for heat recovery or stored in the geo-loop rather than rejected to the outdoor atmosphere. During the Wisconsin winter months, the chilled water is sent to the geo-loop and draws heat back out of the ground. By storing heat energy rather than rejecting to the atmosphere, ABB reduces energy consumption in the heating months by not burning fossil fuels or using electric heat.

One air handling unit provides air to the office areas and lab spaces. This AHU utilizes 12 fans with IE5+ ultra premium efficiency EC Titanium motors each with their own VFD. Redundancy and efficiency were paired in this design and the drives' user control panel features were utilized during the system commissioning. After taking occupancy for phase 1, many employees mentioned audible noise from the air vents. Not having full access to the building automation system yet, ABB set out to use the VFDs' control panel interface to understand what was happening. By using data in the drives, presented as a graphical trend on the control panel, ABB identified that the fans were shutting off and turning back on then ramping up to recover the duct static pressure. It was discovered the Start Command from the BAS was intermittently dropping out due to a loose wire. During troubleshooting, the team discovered that the Start Command digital input as well as the Status feedback relay output on all 12 VFDs were each run as a series loop back to the AHU controller. When one or more loose wires were discovered on the status outputs, this was the cause of the



HVACR system is isolated by the area it serves. Phase 1 could have had its own BACnet/IP ring, phase 2 its own as well as phase 3. As each area had been completed, all devices could have been discovered and commissioned with the redundancy of the BACnet/IP ring. As the following phases were added, each would have its own ring to connect to the supervisor. As issues arise from the construction or commissioning process, only areas involved would have been exposed, leaving the existing networks unaffected.

BAS stopping and starting the fans. Providing this information to the controls contractor, they were able to revise the programming and use the BACnet point BVO running status for each drive status, providing a better design of the fan array.

Finally, to help offset the electrical demands of the facility, 332 kW of solar panels are also installed on the building roof. After the first year of operation, the solar system generated 413 MWh of power for the facility, saving approximately 640,000 pounds of CO<sub>2</sub>. Through the integration of the BAS, a future phase of the project will combine data from the integrated power meters with the power factor correction capabilities of active front end drives to further improve building energy efficiency.

### Redundant Equipment Benefits

The office area central plant design includes N+1 pumps programmed from the BAS to rotate operation and provide redundancy in case of any failure or planned down time for maintenance. To further take advantage of this design, ABB's R&D group can test new firmware versions in a live system before release. For example, when a new addition to the BACnet/IP fieldbus adapter was ready, the adapter was applied to drives in the mechanical room for real world verification and testing, before making it available to the

public. In a case like this, ABB confirmed the new firmware did not negatively impact the network and existing devices as well as working with the BAS to discover the new BACnet/IP points and confirm they were reading as expected.

### BACnet/IP Connectivity

Tying together all the HVACR equipment, lighting controls, monitoring and alarms is the ABB Smart Buildings INTEGRA building automation system connected to each piece of equipment over BACnet/IP. Ring topology was implemented looping around the building from the supervisor panel through the chiller plant and AHU, to the VAV boxes and terminal controllers, out to the production area RTUs as well as the R&D space. While the final design may work with many devices all interconnected, this topology leads to difficulties during the phased construction.

For example, with two links of the BACnet/IP cabling leaving the supervisor's rapid spanning tree protocol ethernet switch, the phase 3 R&D area was incomplete with devices not installed closing the link in the ring. Several production area RTUs have needed additional commissioning and when these units have been shut down, many other devices go offline as well. While this may be common during the construction process, phase 2 included ramping up manufacturing production. It was becoming more critical for the HVACR equipment to be online, not only for occupancy but also production quality control.

As a lesson learned on the project, an ideal opportunity for BACnet/IP and a phased construction would have been to implement several network rings. Each phased construction

While it is inconvenient for the facilities team working to understand where issues are to trace down with the single ring network, the advantages of the multiple BACnet/IP ring topology could have been leveraged to make the system more robust during construction, commissioning and possibly future expansions.

### Building Analytics

With the focus on energy and operational efficiency, the building's design roadmap is to showcase and leverage analytics to continuously optimize the building's performance. Using the BAS and equipment communicating over BACnet/IP, the monitoring data, trends, active setpoints, energy consumption and more is continuously collected to understand how the building is operating. From the chiller's geo-loop energy meter, to the building's electrical power meters, energy data available from the VFDs, the lighting system occupancy sensors, the VAV zone temperature sensors and the rooftop solar energy being produced, the information will be used to adjust temperature or pressure setpoints and occupancy schedules to reduce energy needs without negatively impacting office space comfort or production area requirements.

This new building was designed to accommodate ABB's current needs and future growth, as the products manufactured in this facility support the HVACR industry's demand for efficiency and sustainability. From the flexible workspaces in the offices, the adaptable production area utilizing advancements in automation, and the efficient HVACR systems with BACnet integration, the building meets today's demand while being flexible to tackle tomorrow's challenges.

### ABOUT THE AUTHOR

Starting with ABB in 2022, I have been working in the HVAC industry since 2015. My background has been HVAC equipment and Building Automation System design, programming, implementation, startup, commissioning, training and support. With ABB, I am an HVACR Application Engineer and I support our Channel Partners with complex drive applications and answer questions assisting with variable frequency drives in the HVACR market.



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