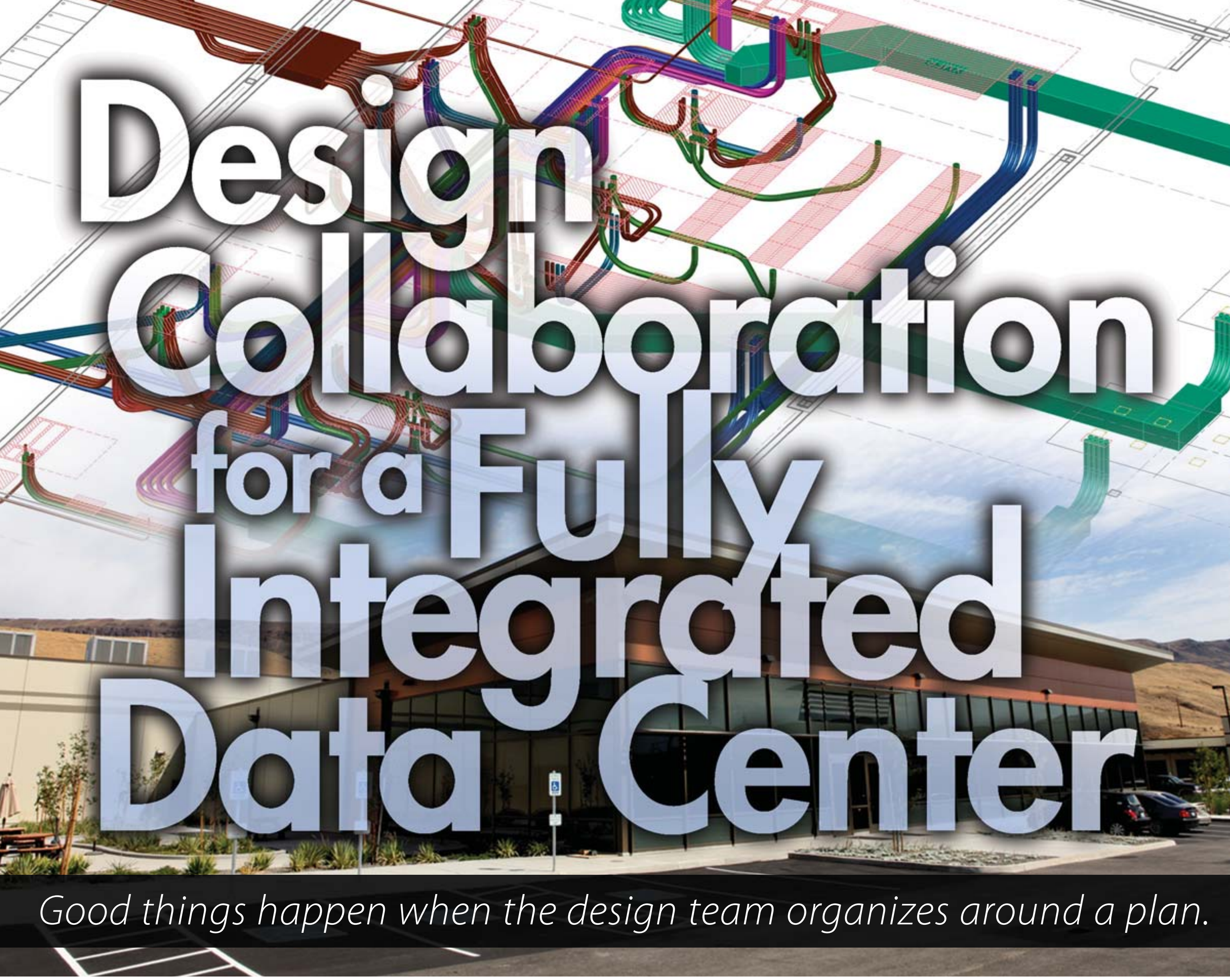
Design Collaboration for a Fully Integrated Data Center



Good things happen when the design team organizes around a plan.

BY KEITH LANE

Design collaboration between the owner/operator and the electrical and mechanical engineers in the design and construction processes of two large Sabey Data Center Campuses—one in East Wenatchee, WA, and the other in Ashburn, VA—was key to the success of the projects. In both these projects, the owner, MEP, and architectural team, and construction and operations teams collaborated to form a fully integrated data center team, producing offerings at various Tier levels, including turnkey and powered shell spaces.

Today, the Wenatchee campus Phase 1 is already built and populated with initial tenants, and the Ashburn Campus is designed, permitted, and ready for construction.

In retrospect, the integrated data center team identified the following six features of Sabey's prototype design that led to the success of these facilities.

Keith Lane has over 20 years of experience in the design and implementation of mission-critical facilities. He is a professional electrical engineer licensed in thirteen states, a licensed general electrical administrator, a registered communications distribution designer, a network transport system specialist, a registered telecommunications project manager, a lighting certified qualified professional, and a LEED-accredited professional. Keith is the president/CEO and chief engineer of Lane Coburn & Associates and can be reached at klane@lanecoburn.com or www.lanecoburn.com.

- Distributed-redundant electrical and mechanical systems with distributed static transfer switches produce extreme reliability and eliminate single points of failure.
- Efficient mechanical systems include scalable air-handling units (AHUs), airside economizers supplemented with indirect evaporative cooling, contained hot aisles, no raised floors or CRAC units, and other innovations resulting in very low average PUE values.
- Full double-conversion online uninterruptible power supplies (UPS) provide high reliability and 97 percent

The Intergate.Columbia data center campus in Wenatchee, WA.

efficiency through a wide range of loads.

- Electrical and mechanical systems are separated by quadrant for scalability, reducing cost, and improving reliability.
- Eliminating the raised floor eliminated the requirement for EPO systems.
- State-of-the-art control and monitoring systems with open protocol are used to provide monitoring at multiple campus locations.

Individual tenants in the Wenatchee facility may have modified the Sabey generic prototype to fit their individual needs.

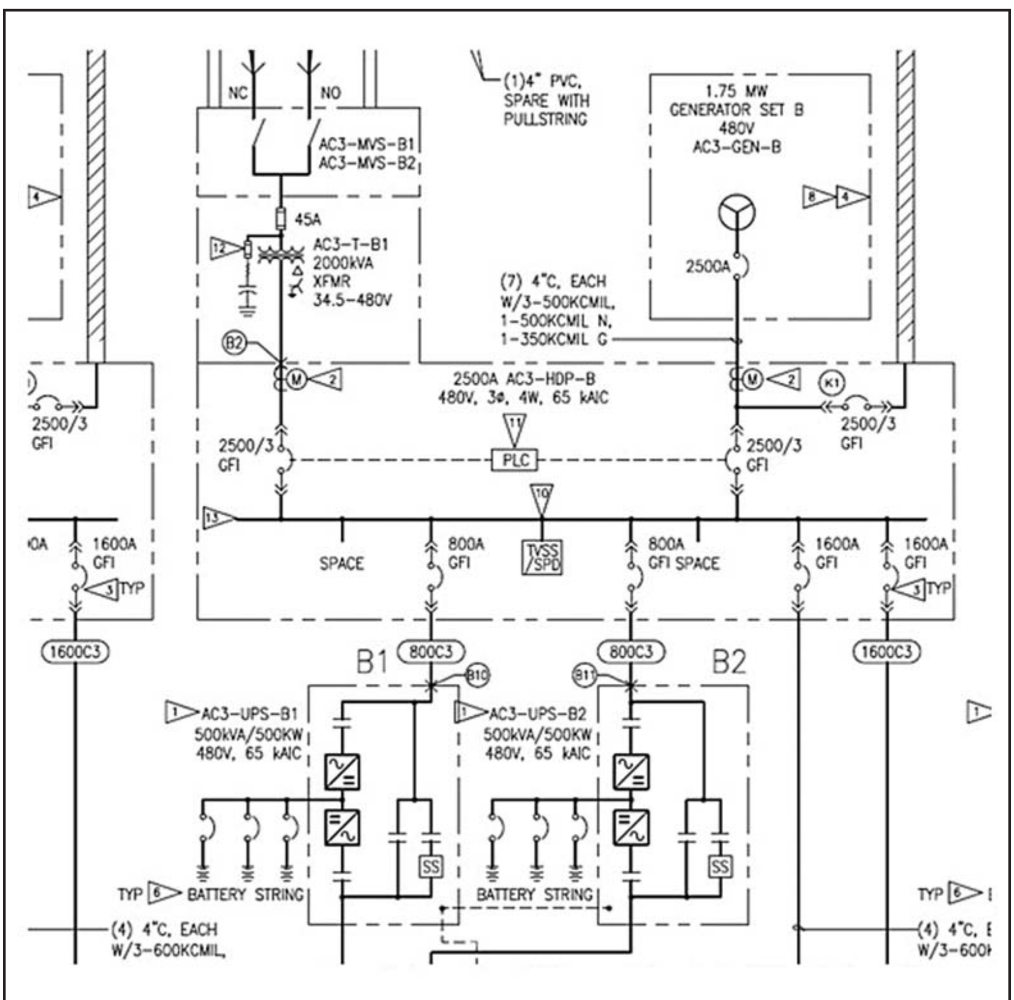
TEAM INTEGRATION

John Sabey, president of Sabey DataCenter Properties noted, “The fully integrated data center team, consisting of engineers and architects working with Sabey’s construction, leasing, marketing, and data center operations and finance teams, provides maximum efficiency to the development of each project, from property acquisition to fully commissioned data center. This collective team strives to ‘right size’ the reliability, scalability, and economics of the prototype from day one.”

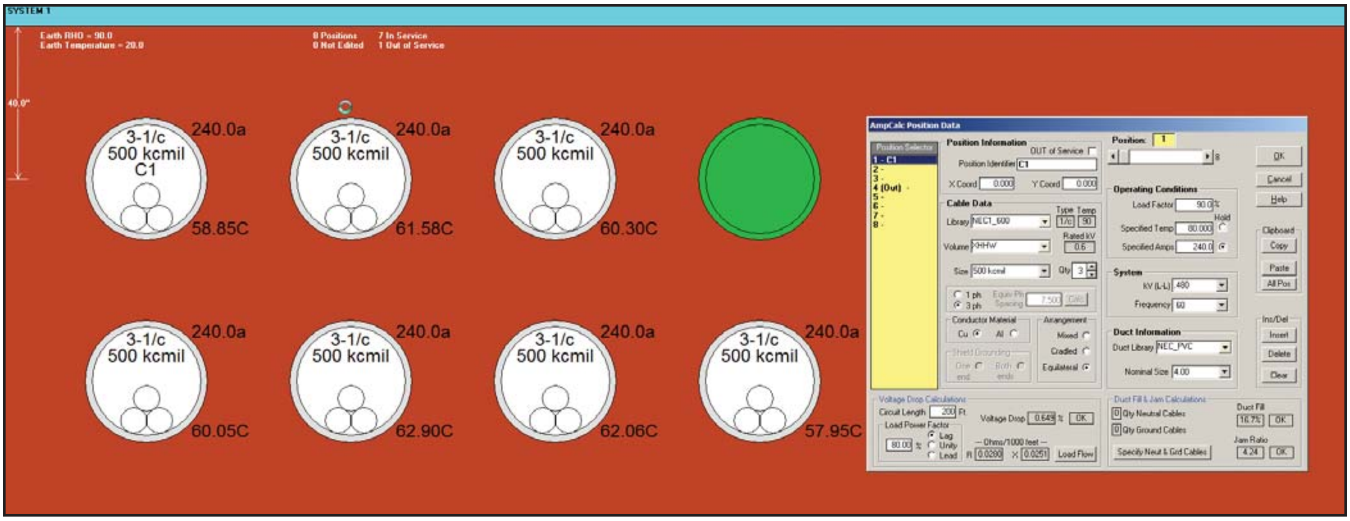
John Ford, vice president of Sabey DataCenter Properties said, “The Sabey team starts by working directly with utilities to obtain the most reliable and cost-effective high-voltage system infrastructure to provide power to dedicated substations and campus medium-voltage distribution systems.”

Sabey’s data center team performs multiple design iterations and cost studies to size electrical and mechanical components, including generators, UPS systems, static transfer switches, electrical service equipment, PDUs, and AHUs. The team actively seeks participation from utility companies to provide the most energy-efficient system possible.

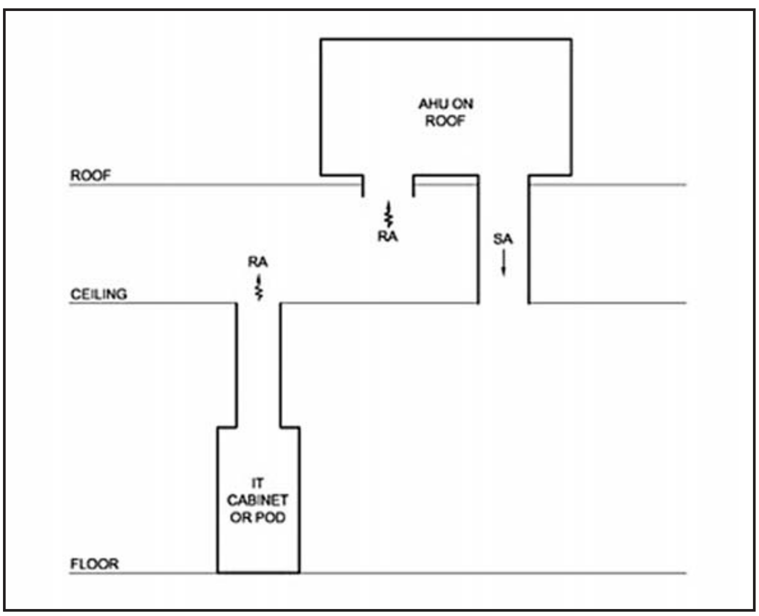
The design team relies on the construction team’s experience relating to development challenges, cost control issues,



A portion of the Intergate.Ashburn (VA) prototype design



Extensive 3D modeling was provided on the prototype design between the MEP firms to eliminate conflict and risk during construction. Neher-Mcgrath duct bank heating calculations were provided and integrated with the 3D Model to ensure no risk of overheating the conductors for the life of the data center."



Air flow from roof-mounted AHU to data center floor through the contained hot aisle.

and the fast-track construction process to provide value engineering feedback.

Kara Anderson, director of Architecture of Sabey DataCenter Properties said, "The architectural team leverages its experience in entitlements and development to expedite the construction process and speed to market. The architectural team concentrates on the use of cost-effective architectural elements that enhance the look/feel of the project without unnecessary budget overruns."

According to Ford, "Leasing/marketing team members contribute their market intelligence to ensure that design and costs are compatible. The leasing team's continuous oversight helps to ensure that the design process stays on track for delivery of a market-driven design and an economically viable product. This is unique in the data center development process."

"Finally, the financial team uses their clear understanding of capital supply and weighted average cost of capital (WACC) to provide guidelines as to where return expectations lie. This helps to ensure that the completed product fits the mold for the majority of the market and is constructed at a price that enables Sabey to meet return hurdles at market leasing rates," said Sabey.

ELECTRICAL DESIGN NARRATIVE

John Sasser, vice president of operations of Sabey DataCenter Properties said, "For the prototype design, the full facility build out is based on four independent power trains for the larger buildings and three independent power trains for the slightly smaller building. Each power train consists of a utility transformer, a standby power generator, associated switch gear, UPSs, and mechanical loads. The electrical distribution is a distributed redundant topology with full N+1 redundancy."

Each power train includes two large on-line double-conversion, extremely efficient UPS modules. Each UPS consists of an internal bypass and each set of two UPS modules had a separate maintenance wrap bypass with a solenoid key release unit.

Each IT cabinet downstream is fed from two power sources. Single-cord servers connect to rack-mounted ATSs to integrate the second feed to the rack level. The system can lose one complete power train without affecting the critical IT or mechanical loads.

Mechanical equipment is served by two sources of power. Roof-mounted units with integral ATS allow a

Online double-conversion UPS system downstream of a standby generator with complete electrical isolation between the power source and the critical load

500-kW online double conversion UPS

transfer at the roof unit level to the secondary source if the preferred source goes out.

"Large floor-mounted static transfer switches (STS) are provided to ensure that a maintenance operation will not cause dual cord servers to be fed from a single source," said Sasser.

If an entire power train fails, the remaining power train(s) have the capacity to pick up the total critical server and mechanical load.

If one of the UPS modules in a power train goes into bypass, the other UPS will also go into static bypass and the source of power will remain viable and redundant to the other fully conditioned power train.

Each PDU is sized for 2N, so if there is a failure of a PDU, the entire load can be handled by the other PDU. Large, floor-mounted STS feed distribution switch gear that then feeds PDUs configured in a 2N topology.

The main switch gear consists of two switches with a main-tie-tie-main. Each unit substation can be fed from either of the main switch-gear boards. The transformer switch position can be selected between main switch gear 1 and main switch gear 2 for full concurrent maintainability. Additionally, there are spare conduits brought from the main switch gear to the unit substations for redundancy.

The system has full N+1 redundancy. Floor-mounted static transfer switches allow for full concurrent maintainability without reducing dual-cord servers to a single cord. Tier Certification by the Uptime Institute was not pursued, but the data center is designed towards a Tier 3 plus scenario.

"Extensive 3D modeling was provided on the prototype design between the MEP firms to eliminate conflict and risk during construction. Neher-Mcgrath Duct Bank Heating calculations were provided and integrated with the 3D Model to ensure no risk of overheating the conductors for the life of the data center," said Scott Coburn of Lane Coburn & Associates.

MECHANICAL DISTRIBUTION

Mechanical equipment is served by two sources of power. The roof-mounted units come integral with an ATS to allow a transfer at the roof unit level to the secondary source if the preferred source goes out. Two control circuits are provided and are UPS backed.

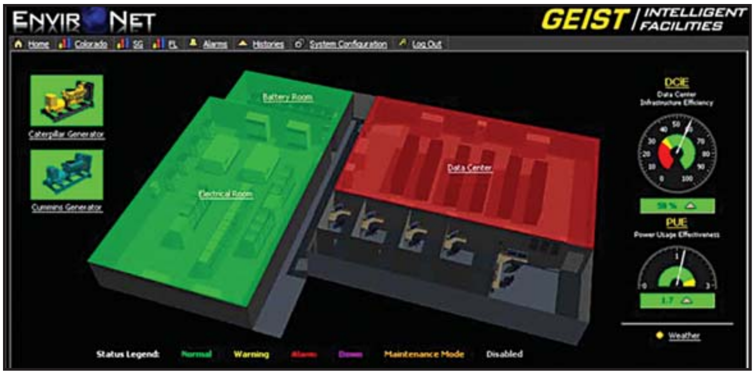
IT pods (racks) are fully contained to eliminate hot/cold air exchange and to significantly increase energy efficiency. Roof-mounted AHUs provide cold air outside the racks. The rack enclosures are considered the hot aisle.

This mechanical system provides sustainable cost savings and eliminates the CRAC units on the floors. This allows for increased rack floor space and eliminates the need for raised floors and an EPO system.

Roof-top AHUs take advantage of outside air economizers and direct data center space cooling without CRAC units for optimum PUE.

FULL ONLINE DOUBLE-CONVERSION UPS SYSTEMS

Online double-conversion UPS systems provide the highest level of power quality protection and are typically utilized in data centers where uptime is essential for system operation and financial viability. They utilize a power circuit and an inverter that changes incoming ac power into dc power through a rectifier, into batteries, and then reconverts the power back to regulated ac through an inverter.



Data center screen shot illustrating real time PUE and DCIE

This double-conversion continuously provides conditioned power to the load and protection from power outages.

Double-conversion UPS systems can accommodate significant swings in supply frequency and continue to operate without going to battery operation.

The typical data center raised floor is used to distribute air from CRAC units and is considered a plenum. All data cables must be UL listed for use in a plenum unless all conditions of Article 645 of the NEC are met, which include the addition of an EPO and a dedicated mechanical system serving the raised floor plenum. These requirements can be avoided if a raised floor is not utilized as an air plenum.

BlackRock, One of Sabey's Large Tenants

BlackRock, a global leader in investment management, is one of the large tenants at the Sabey Intergate.Columbia Campus. The fully integrated design process was taken to the next level with the highly tech savvy BlackRock team, which developed its own electrical and mechanical schematic designs and worked hand-in-hand with Sabey and the MEP engineers to complete the design and build based on BlackRock's own specific reliability requirements. This marriage between the Sabey team and the tenant further illustrated Sabey's flexibility to offer a prototype design, but allow the tenant to leverage their own designs with the unique attributes offered at Intergate.Columbia.

The Intergate.Columbia data center, Wenatchee, WA, BlackRock build out. Shown here are 415/240-Vac modular IT power distribution units.

The Intergate.Columbia data center, Wenatchee, WA, BlackRock build out. The racks are populated with dual 415/240-Vac plugs.

Barry Novick, global data center manager for BlackRock Inc., said, "The entire Sabey organization embraced our unique data center architecture and aggressive project schedule. We utilized a large variety of technologies, contract vehicles and vendors that normally are not found together on the same project. The team delivered on-time, under budget and met our design objectives. This partnership approach provided an outcome that a traditional "arms-length" relationship could not have duplicated."

MISSION-CRITICAL RATED GENERATORS

Most life safety and legally required generator systems are standby rated, typically rated to run 100 hours/year with a load factor of 60 percent or less, peak demand of 80 percent of standby rated load, and 100 percent available during an outage.

Prime-rated generators are typically standby generators derated to 90 percent of the standby rating, with no limit to the number of run hours per year. Load factor is rated at 60 to 70 percent, and peak demand is 100 percent of prime rated load for occasional use but for less than 10 percent of the operating hours.

Continuous rated generators are typically standby generators derated to 80 percent of the standby rating, with no limit to the number of run hours per year. Load factor is 70 to 100 percent and peak demand is 100 percent of continuous rated load for 100 percent of operated hours.

Load factor is the sum of the running load divided by the hours of operation under those loads.

A typical data center serving both server and mechanical loads will have a load factor in the 80 percent range; standby and prime-rated generators are not suitable for a load factor higher than 70 percent. As such, Sabey utilizes "mission critical-rated" generators with a load factor rating of 85 percent.

CONTROL AND MONITORING SYSTEM

All prototype buildings utilize a full building automation system (BAS) for controls and an electrical power monitoring system (EPMS) for monitoring and alarms. Full integration requires coordination with all vendors, the tenant, and the monitoring system supplier.

The Environet monitoring system offers fully customizable screens, user-defined alarm thresholds, monitoring of multiple protocols, maintenance schedules, external alarm notification, multi-user based permissions, power capacity planning, energy cost analysis, and integration with external systems.

CONCLUSION

A comprehensive approach to the design, construction and commissioning of mission critical facilities is required to meet the needs of tech savvy and demanding owners and operators in today's economy. The Sabey team approached these challenges from the early stages of site selection and utility negotiation through to design, value engineering, construction and the final stage of commissioning with innovation, flexibility, and full team collaboration. ■

REPRINTS OF THIS ARTICLE are available by contacting Jill DeVries at devriesj@bnpmedia.com or at 248-244-1726.