A benzene-conversion project designed and built under leadership of Burns & McDonnell engineers may not be the biggest, most complicated or far-reaching of its kind.

But it’s a solid start.

“This is serial number 1,” says Bryan Phillips, project manager in the Process & Industrial group at Burns & McDonnell. “No plant in the refining industry has been designed or built to the specifications and requirements of this particular project.”

Background
Tightened environmental regulations meant that Murphy Oil Corp.’s refinery in Superior, Wis., required modifications.

Enter Burns & McDonnell, hired in January 2011 to reduce benzene in the refinery’s gasoline pool. And with Murphy Oil seeking to minimize risk while navigating its own financial challenges, Burns & McDonnell agreed to take on the project as a lump-sum execution.

Burns & McDonnell already had experience at the Superior site. Phillips had worked on installation of a benzene splitter and revamp of sulfur-reducing diesel and kerosene hydrotreaters, upgrades completed in 2010.

Murphy Oil sold the Superior refinery to Calumet Specialty Products Partners LP in October 2011.

Challenges
The project’s unique challenges had emerged 12 months earlier, as officials from Murphy Oil outlined their needs:
• Reduce benzene concentration in the gasoline pool to less than 0.62 percent, to comply with the Environmental Protection Agency’s mandated Mobile Source Air Toxics (MSAT-2) list.
• Squeeze equipment onto a site covering less than 4,900 square feet, smaller than even the smallest of new residential lots in Superior.
• Finish work by the end of 2011, despite such projects typically taking six to eight months for design plus another 10 to 12 months for construction.

Engineers also were preparing to use a new technology for accomplishing the project’s top task: Convert benzene — a known carcinogen and normal byproduct of the refining process — into a harmless fuel ingredient.

Solution
Murphy Oil chose to use BenzOUT™, marking the first such application in the refining industry for the reactive technology licensed by Badger Licensing LLC. Refinery streams containing benzene concentrate are fed directly into a reactor, where they combine with propylene and a proprietary catalyst to convert the benzene molecules into a cumene product — a benign liquid to displace benzene in the gasoline pool and maintain fuel performance.

Getting the entire system in place and on time wasn’t easy.

The Burns & McDonnell team started ordering equipment and materials even before executing a final agreement. Knowing time was short, Burns & McDonnell contracted early for procurement of long lead pumps, reactors and a 110-foot-tall stabilizer tower.
“That was the only way,” Phillips says. “Receipt of equipment drawings to support accelerated engineering and delivery of equipment to the job site drives the entire project schedule.”

Modular construction also helped. Crews preassembled the project’s complicated network of pipes, instruments and process equipment at a shop outside St. Louis. Drivers then maneuvered the process modules — each 40 to 50 feet long, stretching 16 feet wide and another 14 feet tall — on wide-load trucks to Superior, where cranes stacked the steel-frame building blocks into place, minimizing construction time on site.

Using a design-build approach allowed each step of engineering to be followed closely by appropriate requisition, fabrication and installation.

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**Outcome**

When the team finished its work Nov. 11, 2011, the project had gone from concept to completion in 13 months.

The new system converts up to 5,500 barrels of benzene-containing gasoline each day. The reformulated fuel is enough to bring the entire refinery into compliance with MSAT-2 limits.

Burns & McDonnell also developed manuals for training and maintenance, conducted on-site maintenance and operator training, and provided personnel for startup support — all without a single Occupational Safety and Health Administration recordable incident.

Dan Eliason, construction manager for Burns & McDonnell, assembled the project’s construction packages. Phillips says. David Kirby, site manager, led the construction management team’s efficient oversight of subcontractors, and Jeff Swierzek, lead process engineer, was instrumental in developing startup procedures and helping Murphy Oil start up the unit and meet specifications.

“I had a great team behind me,” Phillips says. “Everything just fell into place.”

For more information, contact Bryan Phillips, 816-822-3155.

Crews installed a stabilizer tower (top photo) on July 28, 2011, then placed a reactor (center left) and modules (center right) in August on the way to project completion (bottom) on Nov. 11, 2011.