It won’t take long for the language in National Petrochemical & Refiners Association (NPRA) news releases to catch your eye.

“Unrealistic.”
“A knockout punch.”
“A devastating impact on consumers.”

Environmental Protection Agency (EPA) clean fuels regulations are the target of the NPRA’s gloom. While the language is colorful, the message is stark: clean fuels requirements — while having a positive impact on environmental quality — have presented the refining industry with one of its biggest challenges.

“Quite a few U.S. refiners — representing several hundred thousand barrels of gasoline production — have indicated they may have to sell refineries or close them to meet low-sulfur requirements,” says Stephen Hoak, a ConocoPhillips engineer currently stationed at Burns & McDonnell’s world headquarters. “When you add the lost capacity to the investments that major refiners are making with their clean fuels programs, some are saying the impact will be felt by consumers in the way of higher gasoline prices.”

The clean fuels regulations are the biggest of a number of issues facing the refining industry, including a desire to lessen dependence on foreign oil and a rising interest in alternative fuels. Burns & McDonnell can help companies — from established firms like ConocoPhillips to smaller independent refiners — meet the challenges of the industry. It is a mindset that can best be summarized by a poster found near the lobby of Burns & McDonnell’s headquarters: “Every ConocoPhillips dollar saved is an investment in our future.”

**Clean Fuels**

Most refiners will have to meet Tier 2 gasoline sulfur standards, which reduce the sulfur content in gasoline from an average level of 300 parts per million (ppm) to an average of 30 ppm by 2004. Separate standards must be met for diesel fuel by 2006. In addition, the EPA is currently reaching settlements with several refiners for nitrogen oxide (NOx) and sulfur oxide (SOx) violations of the Clean Air Act. Further, Phase II reformulated gasoline (RFG) requirements are currently under way for high-ozone areas of the country.

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ConocoPhillips is spending about $146 million to meet the Tier 2 sulfur regulations at its Ponca City, Okla., refinery. The project includes six additions to the plant: a hydrotreater to reduce gasoline sulfur, an isomerization unit to offset octane lost in the desulfurization process, a hydrogen plant, a flare, flare gas recovery unit, and a cooling tower.

Burns & McDonnell is providing engineering, procurement and construction (EPC) services to incorporate all the new units into the refinery. Commonly referred to as Outside Battery Limits (OSBL) work, the scope includes utility services, all process piping tie-ins to the existing refinery, new pipe racks, existing pipe rack modifications, electrical, and controls and instrumentation.

“OSBL work is as critical to a refinery’s operation as the new process unit,” says John E. Nobles, president of Burns & McDonnell’s process and industrial group. “It’s our job to get to the new process units the critical commodities such as steam, water, natural gas, electricity, nitrogen and the gasoline that will be processed.”

Burns & McDonnell is also providing construction services for the process units themselves, commonly referred to as Inside Battery Limits (ISBL) work.

The 35-person project task force composed of Burns & McDonnell and ConocoPhillips employees shares workspace at Burns & McDonnell’s corporate headquarters. The team is focused on meeting the project schedule while at the same time providing as much value as possible to ConocoPhillips.

To help control costs, Burns & McDonnell chose a multiple subcontractor approach to the project. In this approach, the job is divided into several parts and bid to several contractors. For each job, the costs are well-defined, and the contractor is working from substantially completed designs.

This contrasts with another common approach – direct hire – where a single contractor is brought to the job early on. This approach is not as effective at controlling costs and maintaining efficiency.

“With the multiple subcontractor approach, the contractor arrives at the job site and already has areas to work on,” says Henry Aboujawdeh, Ponca City project manager. “It has worked out very well, generating a significant cost savings.”

“OSBL work is as critical to a refinery’s operation as the new process unit.”
Value Engineering

When the Ponca City project is complete in 2004, it will be noteworthy not only for its regulatory promise, but for its efficiency. For example, the C5/C6 isomerization unit Burns & McDonnell is installing at Ponca City will replace the octane lost in the hydrotreater at a lower cost than with other processes while maintaining the plant's gasoline yield, says Ken Masters, a Burns & McDonnell associate chemical engineer.

Octane is the characteristic of gasoline that helps car engines run more efficiently and prevents the “knocking” that occurs with lower-octane grades.

“Without the isomerization unit, the next best option to boost the octane in the gasoline stream was to increase reformer severity,” Masters says. “However, this increases operating costs and reduces overall gasoline yield.”

Since beginning the clean fuels job, Burns & McDonnell has received other Ponca City projects from ConocoPhillips. Among them is one that will help the refining company offset the cost of its clean fuels program.

The bottoms upgrading will replace an existing vacuum distillation column with a larger one to allow the refinery to process additional amounts of heavier crude oils. Heavier crude oils are typically cheaper to purchase, which will improve Ponca City’s operating margin and long-term profitability.

“Ponca City has taken this opportunity to improve its outlook,” Nobles says. “They are making a commitment to being open and operational for the future.”

Refinery Emissions

The Tier II sulfur regulations are not the only ones refineries have to meet. Already, some have signed consent decrees with the EPA to bring them into compliance with the Clean Air Act (CAA) with regard to SOx and NOx.
“When the CAA was passed, not a lot was done to comply with it,” says Geoff Stephenson, process technology manager. “So the EPA and the states started going to industry a few years later and negotiating consent decrees with them to bring them into compliance. There are a handful of refiners and chemical producers that fall into this category. Many more are still in the negotiation phase with states and the EPA.”

Typical NO\textsubscript{X} and SO\textsubscript{X} sources at a refinery include flare gases, fluid catalytic cracking units, process heaters and boilers. Many refiners are turning to flare gas recovery units to knock out a major source of SO\textsubscript{X} headaches.

A flare gas recovery unit (FGRU) works by taking excess gas from refinery operations that would normally be burned in the flare and compressing it to a high enough pressure so it can be reused. This not only reduces emissions but also helps reduce refinery operating costs.

“When viewed as a regulatory compliance project, FGRUs don’t offer the payback of capital that goes into them,” says Dominic Varraveto, a Burns & McDonnell associate chemical engineer. “When taken together with potential savings in operational costs, they may make sense for the refinery.”

Much of the flare gas recovered in an FGRU can be used as fuel after the sulfur, usually in the form of hydrogen sulfide, is scrubbed out.

Burns & McDonnell is installing the second FGRU at the Ponca City refinery. It will help ConocoPhillips meet the terms of its consent agreement with the EPA.

Burns & McDonnell has recognized the importance of the FGRU to the refinery’s operations, incorporating controls and piping to allow a temporary unit to be installed and operating while extensive maintenance is performed on the main unit.
“Because the flare gas recovery unit is part of the consent decree, reliability is extremely important,” Masters says.

Reliability is also important for ConocoPhillips, as it works to meet the demands of a changing industry.

“When it comes to configuring refineries to produce low-sulfur gasoline, what works best for one refinery may not be the best solution for another.”

“The challenge for most refiners is determining the optimum combination between new processes and modifications to existing equipment that will meet product requirements,” says Dominic Varraveto, Burns & McDonnell associate chemical engineer. “It requires sound knowledge of both refinery configuration and available technology.”

There are a number of factors to consider when weighing how best to desulfurize a refinery’s gasoline stream. First, if a process technology is to be used, before it is selected the refinery’s product streams and their corresponding sulfur contents must be identified. Then a strategy can be developed for each stream that results in an on-spec product.

A second decision made early in the process is whether to pre-treat or post-treat. Although capital intensive, pre-treatment can increase product volume and quality. Post-treatment does not have the advantage of increasing product volume or increasing market share, but it is less capital-intensive.

“One approach doesn’t have an advantage over another in general terms, but when you look at each specific refinery’s situation, one may be better than another,” Varraveto says.

In any event, hydrotreating, which is a significant part of Burns & McDonnell’s work for ConocoPhillips in Ponca City, Okla., will be an integral part of any desulfurization solution. It has been used to remove sulfur for decades, and process and catalyst improvements in recent years have enabled refiners to use it to meet increasingly stringent regulations.

“The current generation of hydrotreating processes is customized for treating many types of gasoline blendstocks,” Varraveto says.