On December 1, 2015, the U.S. Environmental Protection Agency (EPA) published a final rule reflecting the residual risk and technology review conducted for the petroleum refinery source categories regulated under the National Emission Standards for Hazardous Air Pollutants (NESHAPs). In addition to other changes, this rule includes new standards and approaches governing flaring, pressure relief devices, and equipment maintenance activities. The rule also imposes the first-of-its-kind fenceline monitoring program with the purpose of providing additional fugitive emission compliance assurance. This article is intended to help inform others in the regulated community whose source categories will undergo a NESHAPs risk and technology review. It provides an overview of the major new requirements and discusses the rule development process.
The article also highlights the value in engaging with EPA staff throughout rule development, particularly early in the process when plans are being made to develop source and emission inventories that are vital inputs to the residual risk model and to EPA’s understanding of the source category. The unparalleled effort to comprehensively characterize the emissions from the petroleum refining industry provided a strong foundation for the risk modeling which confirmed that the risk from refinery operations is low and that the public is protected with an ample margin of safety. Additionally, as EPA is now developing specific emissions standards for periods of equipment startup and shutdown, it is critically important that the agency understand the safety issues associated with these operations to ensure they are fully considered during standard setting.

Overview of EPA’s Process for Regulating HAPs
Section 112(d)(2) of the U.S. Clean Air Act requires EPA to develop maximum achievable control technology (MACT) standards on a source category basis. The MACT standards governing the petroleum refining source category were promulgated in two parts (1995 and 2003). The Act (Sec. 112(d)(6)) also requires EPA to periodically review and revise the standards, as necessary, taking into account developments in practices, processes, and control technologies. In addition to this technical review, the Act (Sec. 112(f)(2)) requires that EPA perform a risk assessment to determine whether, after implementation, the initial MACT standards provided an ample margin of safety to protect public health. To further complicate this already challenging activity, in response to the 2008 Sierra Club decision, EPA chose to promulgate specific emissions standards for certain operating scenarios (e.g., startup, shutdown, and equipment maintenance), which were previously subject to general requirements.

EPAs process for performing the technical review and risk assessment typically consists of (1) updating source and emission inventories; (2) performing site-specific risk modeling to assess both cancer and non-cancer risk to the community; and (3) as warranted, assessing the cost, efficacy, and operational impacts of additional control measures.

Important Learnings from the Refinery Sector Rule Regulatory Process
Source and Emissions Inventory
In previous attempts to perform risk modeling on the petroleum refining source category, the basis of EPA’s petroleum refinery source and emission inventory had been questioned. With industry support, EPA standardized the source and emissions inventory, thereby improving the reliability of their risk modeling for the source category. For example, EPA developed a comprehensive Emissions Estimation Protocol for Petroleum Refineries, which served as the basis upon which refiners were required, under EPA’s Information Collection Request (ICR), to estimate their emissions. To further augment the database, EPA required refiners to perform extensive emission source tests as part of the ICR effort.

In round numbers, the industry spent approximately $50 million to develop this inventory. Unprecedented in scope, the information obtained provided a standardized and transparent basis for the risk assessment modeling which followed.

Risk Assessment Modeling
For every refinery in the country, EPA modeled inhalation and multipathway (e.g., ingestion) risks for cancer and noncancer to the neighboring community. The results of this modeling confirmed that the risk from refinery operations is low and that the public is protected with an ample margin of safety.

To inform industry’s analysis of EPA’s modeling results, third-party assistance was obtained to perform a parallel risk modeling, using the same emissions inventory and models as EPA. This identified inaccuracies in EPA’s database, such as erroneous emission rates and most importantly mislocated sources, which, if not corrected, could have had a profound impact on the modeling results.
Assessing the Impacts of Additional Control Measures
Given the acceptable risk results for the industry, the Act requires that any additional control measures be cost-effective. Such analyses required ongoing information sharing between industry representatives and EPA staff. Industry provided extensive supporting documentation related to the impacts of various control strategies on equipment such as flares, pressure relief devices, delayed cokers, and other major process units. As another example, industry voluntarily undertook a fenceline monitoring pilot program to help inform this aspect of the rule.

As mentioned above, in this review EPA also developed revised standards applicable to periods of startup and shutdown. To ensure personnel safety and avoid damage to equipment, while also minimizing emissions, such operations are very carefully planned and subject to numerous other federal regulatory safety and risk management programs. Therefore, it is critically important that the feasibility and safety implications of any new standards for these operations be understood and carefully considered. Such understanding requires detailed input from experts who are intimately familiar with the design and operation of such equipment.

New Developments from the Refinery Sector Rule
Flaring
The requirements for flares were significantly revised in this rulemaking. Flares must now meet a net heating value in the combustion zone of 270 Btu/scf when combusting regulated material. Based upon extensive industry flare test data, EPA selected this value to assure there is sufficient heat content in the combustion zone to achieve a minimum of 98-percent control efficiency. EPAs approach addresses a historic concern that, in an effort to avoid any smoking, operators may have added too much steam to the flare, thereby reducing combustion efficiency. It is now recognized that a bright flame, even with traces of visible smoke, is optimally effective for combusting emissions. Demonstrating compliance with this new heat content limit requires continuously monitoring all streams going to the flare for flow rate, and monitoring the flare vent gas for composition or heat content.

The initial MACT standard required flares, during normal operations, to meet limits on tip velocity and visible emissions. However, most existing flares are not designed to meet those limits during emergencies. Therefore, the rule establishes new work practices designed to reduce emergency flaring. Facilities are required to develop flare management plans to minimize flaring during periods of startup, shutdown, and emergencies. Flaring events that exceed certain criteria for tip velocity and/or visible emissions require the facility to perform a root cause and corrective action analysis and take corrective action, as appropriate, to prevent a recurrence.

Pressure Relief Devices
All refinery equipment is protected from catastrophic failure through the use of pressure relief devices (PRDs). In emergency situations, these devices function to relieve the pressure within the equipment prior to equipment damage and potential rupture. While many PRDs are routed to flares to control emergency releases, this is not always feasible. Under the final rule, PRDs that are not routed to control must be equipped with a monitoring system that identifies and immediately
notifies the operator of a release. Additionally, each such PRD must be equipped with at least three redundant release prevention measures. In the event of a release, the facility is required to perform a root cause and corrective action analysis and take corrective action, as appropriate, to prevent a recurrence. By providing a system that focuses on minimizing the potential for releases to the atmosphere, this new approach is environmentally protective without incurring the environmental and other negatives associated with adding infrequently used, but continuously emitting controls.

**Equipment Maintenance Activities**

The rule includes new standards applicable to maintenance operations such as equipment shutdown and cleaning, activities that were previously covered by the more general startup and shutdown work practice. Prior to opening a maintenance vent to the atmosphere, the equipment must be purged to a control device to the extent practical until the vapor in the equipment has a lower explosive limit (LEL) of less than 10 percent, or until equivalent low emission alternatives are achieved.

**Fenceline Monitoring**

Although refinery fugitive emission sources such as equipment leaks, wastewater treatment facilities, and storage vessels are already subject to stringent standards, EPA was seeking to improve compliance monitoring in a way that provides additional information to facilities and their neighboring communities. To this end, the rule requires facilities to install a network of passive diffusion tube benzene monitors (see Figures 1 and 2) around their fencelines or property boundaries and replace/submit them for laboratory analysis on two-week intervals. If the annual average benzene level exceeds EPA's specified action level, the facility is required to perform a root cause and corrective action analysis and take corrective action, as appropriate, to address the source of the elevated emissions.

**Conclusion**

The Refinery Sector Rule was one of the most comprehensive regulatory efforts conducted to date under the NESHAPs risk and technology review program. The commitment by EPA and industry to accurately characterize each facility's sources and emissions provided a strong foundation for the risk modeling which confirmed that the risk from refinery operations is low and that the public is protected with an ample margin of safety. The scope of the effort included not only the risk and technology review, but also development of new standards for sources such as flares, pressure relief devices, equipment maintenance activities, and the startup and shutdown of major process units. The first fenceline monitoring program for enhanced fugitive emission compliance monitoring was also adopted.

Throughout the entire process, EPA and industry engaged in an iterative information-gathering process intended to provide the agency with accurate and comprehensive information representative of petroleum refinery operations. This helped EPA meet their regulatory objectives in a manner that did not inhibit safe operations or unintentionally increase emissions. Experts from across the industry were frequently called upon to advise the discussion. The effort that both EPA and industry put into developing the source and emission inventory, in particular, was vitally important to the risk assessment as well as the overall development of the rule. EPA staff welcomed and considered input from all interested stakeholders throughout the regulatory development process.

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