Ubiquitous Industrial and Commercial Boilers and Their Regulation under the Clean Air Act

Robert J. Lambrechts

Though generally unobserved, the boiler is the workhorse of American industry and commercial activity. Industrial and commercial boilers represent about 40 percent of all energy use in the industrial and commercial sectors. There are approximately 43,000 industrial boilers and 120,000 commercial boilers in the United States. *See generally* Energy and Environmental Analytics, Characterization of the U.S. Boiler Industrial Commercial Boiler Population (2005) (EAE Report).

Commercial boilers are normally used to produce steam and heated water for space heating in office buildings, hotels, apartment buildings, hospitals, universities, and similar facilities. Industrial boilers are utilized primarily by five major steam-intensive industries—food, paper, chemicals, refining, and primary metals—which have 71 percent of the boiler units and 82 percent of the boiler capacity. The sheer number of industrial and commercial boilers and the amount of energy they consume make them a significant contributor to the U.S. economic base.

Because of the high capital cost of these boilers, replacing them with more modern units is generally an infrequent occurrence. According to data from the EAE Report, 47 percent of boiler capacity larger than 10 MMBtu/hr (million British thermal units per hour) is at least forty years old, while only about 7 percent of boiler capacity is less than ten years old. The age factor clearly contributes to the emission-control challenges of boiler owners, as older boilers tend to emit more pollution than newer units, while newer units have designs that are generally more fuel efficient and, therefore, emit less pollution.

Industrial and commercial boiler owners are struggling to secure reasonably priced energy to support the industrial and commercial energy needs of the country. At the same time, the boiler owners must comply with an increasingly numerous and complex set of air-pollution control regulations, while remaining competitive in a global marketplace.

This article will address some of the more important clean-air regulatory drivers that are impacting the operation of industrial and commercial boilers in the United States. In particular, this article will address recent regulatory developments from the Environmental Protection Agency (EPA) and the courts and how boiler owners are responding to these developments with boiler emission-control technologies.

This article will also discuss the impact associated with the pending reproposal of the Boiler Maximum Achievable Control Technology (MACT) rule and promulgation of the area source boiler rule, recent developments concerning greenhouse gas (GHG) monitoring and regulation, and the prospect of revisions to the boiler new source performance standards (NSPS) to address GHG emissions. Finally, this article will discuss emission-control equipment strategy options that industrial and commercial boiler owners may employ to bring their units into compliance with these rapidly evolving regulatory requirements.

One of the most controversial issues currently impacting boilers is the status of the National Emission Standard for Hazardous Air Pollutants (NESHAP) for Industrial, Commercial, and Institutional Boilers and Process Heaters, commonly known as the Boiler MACT, which, according to recent EPA estimates, will impact roughly 4,260 boilers and 2,140 process heaters nation-wide. On June 8, 2007, the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit) vacated and remanded the Boiler MACT and the NSPS for the Commercial and Industrial Solid Waste Incinerators Definitions Rule. Based on a court settlement, EPA was required to propose a revised MACT regulation by July 15, 2009, and promulgate a final regulation by July 15, 2010.

Under Section 112(j) of the Clean Air Act (CAA), if EPA fails to promulgate a standard for a category or subcategory of major sources of hazardous air pollutants (HAPs) within eighteen months after its scheduled date, then sources must submit a Title V permit application or revised permit application. The permitting authority would then issue permits with MACT emission limits determined on a case-by-case basis to be equivalent to what would have been promulgated by EPA.

The 112(j) applicability issue associated with the vacatur of the Boiler MACT lies in the statutory language, which specifies EPA's "failure to promulgate a standard" as the trigger for 112(j) requirements. In the case of Boiler MACT and other vacated MACT standards, EPA did not fail to promulgate a standard; rather, EPA promulgated a standard that was subsequently vacated by the court. Therefore, the clear application of 112(j) is complicated by the language of 112(j) itself.

EPA's position is that the vacatur of these rules triggers the

Mr. Lambrechts is a partner in the Overland Park, Kansas, office of Lathrop & Gage LLP. He may be reached at blambrechts@lathropgage.com.

requirements of Section 112(j). Consequently (according to EPA), state and local permitting authorities are required under Section 112(j)—the "hammer provisions"—to set the limits for the affected facilities on a case-by-case basis. Many states are struggling with the MACT hammer because numerous uncertainties exist regarding its implementation. For example, it is not known what Boiler MACT emission standards will be proposed based on EPA's testing request, which is discussed in greater detail below. These uncertainties may affect the information that is required to be filed by facilities in their Part 2 MACT applications. The purpose of the Part 2 MACT application is to submit information about the processes and emissions units subject to Section 112(j) in order for state regulators to complete a case-by-case MACT determination.

To collect data necessary for re-promulgation of the Boiler MACT, EPA conducted an Information Collection Request (ICR) for facilities with combustion units, in accordance with Section 114 of the CAA. The first part of the ICR consisted of an electronic survey of available data for combustion units, which was sent to approximately 3,400 potentially applicable sources. Based on the results of the survey, EPA identified gaps in emission test data and fuels analysis. These gaps relate primarily to emissions due to fuel/material type, combustor design, and emission-control device type. The second part of the ICR addressed these data gaps with fuel variability and stack testing data from representative sources. To accomplish this, EPA identified 187 boilers that were required to conduct these tests, and the test results were required to be submitted to EPA by October 15, 2009.

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In addition, many facilities were required for the first time to test directly for metals, including mercury and dioxins/furans. Multiple fuel boilers were required to monitor emissions across a variety of fuel mixtures. Fuels fired during each test burn also required sampling and analysis. For targeted facilities, the complexity of this emission testing program is similar to that required of hazardous waste combustion units. EPA estimated that the combined effort for stack tests would cost between $54,000 and $190,000 for each boiler. Many facilities with multiple solid and/or liquid fuels were also required to provide 10-sample fuel variability analysis for mercury, chlorine, fluorine, and metals. This entails sampling during the stack test and collection of nine additional fuel analyses spread evenly across a thirty-day period. The Boiler MACT, as of this writing, has a court-ordered proposal date of April 15, 2010, and a promulgation date of December 16, 2010.

Area Source Boiler Rule

In addition to efforts to revise the Boiler MACT pertaining to major sources of HAPs, EPA is also developing an area source boiler rule. "Area" sources are those sources that emit less than 10 tons per year (tpy) of a single HAP or less than 25 tpy of a combination of HAPs. It is estimated that these area source requirements may affect close to 1.3 million boilers, the majority of which have been unregulated sources to date (i.e., boilers less than 10 MMBtu/hr). Promulgation of this area source rule would mean that many nontraditional sources, such as schools, hotels, churches, apartments, restaurants, and health-service facilities, would also be affected by these rulemakings. EPA is under court order to propose an area source rule for boilers by April 15, 2010, and to promulgate a final standard by December 16, 2010. Among other things, EPA is exploring requirements for annual tune-ups, work practice standards, and operator training for both new and existing boilers.

EPA's area source rules usually set emission limits for HAPs based on generally available control technology (GACT), which allows EPA to consider costs and economic impacts of the technology requirements. Of the more than one million sources that potentially would be impacted by the area source boiler rule, it is estimated that less than 1 percent are industrial boilers, 47 percent are commercial boilers, and 53 percent are institutional boilers. *See generally* EPA, Combined Rulemaking for Industrial, Commercial, and Institutional Boilers and Process Heaters at Major Sources of HAP and Industrial Boilers and Commercial and Institutional Boilers at Area Sources (EPA's Panel SER Outreach Meeting 2009).

EPA is required to set emission limits for area source boilers based on MACT for mercury and polycyclic organic matter because institutional/commercial wood boilers are on the list of CAA Section 112(c)(6) source categories. MACT and GACT requirements on these boilers may differ for new and existing facilities. Based on the technical information EPA has reviewed to date, high-efficiency fabric filters appear to be the leading technology for mercury reductions from boilers. Additionally, EPA is considering whether to use carbon monoxide (CO) as a surrogate for the organic HAP and total PM as a surrogate for nonmercury metal HAP. EPA is also evaluating different monitoring, record-keeping, and reporting requirements.

EPA's Endangerment Finding, GHG Monitoring Rule, and Tailoring Rule

On April 24, 2009, EPA published a proposed "endangerment finding" for six GHGs pursuant to Section 202(a) of the CAA in response to the U.S. Supreme Court's 2007 landmark decision in *Massachusetts v. EPA*, 549 U.S. 497, (2007). The proposed finding set the stage for EPA regulation of GHGs not only under Title II of the CAA, which concerns mobile sources, but also under Title I and other sections of the CAA applicable to stationary sources. The comment period for EPA's endangerment finding ended June 24, 2009, and on December 15, 2009, EPA published the final finding (74 Fed. Reg. 66,496). The endangerment finding triggers a CAA requirement for EPA regulation of GHGs as "air pollutants." Now that the endangerment finding has been published in the *Federal Register*, the path is clear for EPA to issue regulations that actually control GHG emissions. The task of regulating this new set of pollutants is potentially enormous as the CAA prescribes no "significance" thresholds for GHGs, and they are emitted by almost every sector of the U.S. economy, including industrial and commercial boilers.

On September 28, 2009, EPA proposed the New Light-Duty Vehicle GHG Regulation (74 Fed. Reg. 49,454) that, in concert with the agency's endangerment finding, will result in the regulation of GHG emissions from motor vehicles. As EPA warned in its July 2008 Advanced Notice of Public Rulemaking in response to the Supreme Court's decision in *Massachusetts*, the regulation of GHG emissions from motor vehicles would have immediate implications for "major" stationary sources of GHG emissions, potentially subjecting them to new CAA permitting requirements. Comments on the proposed motor vehicle GHG rule were due by November 27, 2009, and when the motor vehicle rule is finalized, published, and cleared under the Congressional Review Act sometime in May 2010, EPA will consider GHGs to be "subject to regulation" under the CAA for all categories of new emission sources—even without further regulation. As a result, any new or modified industrial or commercial boiler emitting more than 250 tpy of GHGs must obtain a permit under the Prevention of Significant Deterioration (PSD) program and install best available control technology (BACT) to restrict GHG emissions. Sources emitting more than 100 tpy of GHGs must also obtain a Title V operating permit.

Concerned that literally millions of sources, many of which would include industrial and commercial boilers, could become subject to PSD and Title V permitting requirements when GHGs become regulated air pollutants, EPA proposed the Tailoring Rule on October 27, 2009, to redefine the trigger threshold to 25,000 tpy for a period of five years (74 Fed. Reg. 55,292). Under the proposed rule, during the five-year period, EPA would study ways to "streamline" permit requirements for sources emitting between 250 and 25,000 tpy and, within one year thereafter, would promulgate streamlined regulations. Sources emitting between 250 and 25,000 tpy, however, would not be grandfathered, and if new regulations are issued such sources would likely be subject to those regulations in some currently undefined, retroactive fashion.

Questions have arisen regarding EPA's legal authority to change the statutory PSD and Title V thresholds to 25,000 tpy. Complicating the situation is the fact that permitting is generally administered by state agencies; therefore, states would need to amend their permitting laws and regulations for the Tailoring Rule to effectively limit the application of the permitting programs to sources emitting above 25,000 tpy.

In conjunction with EPA's other efforts to address GHG emissions, on September 22, 2009, EPA finalized the Mandatory GHG Reporting Rule (74 Fed. Reg. 56,260), which, for the first time, requires reporting of GHG emissions from large sources, such as industrial boilers. Congress directed EPA to use its existing authority under the federal CAA to develop rules requiring the reporting of GHG emissions. The Mandatory GHG Reporting Rule does not limit or control GHG emissions, but instead collects information that might be used in future source-specific rulemaking. This rule is estimated to

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affect about 14,000 facilities, representing approximately 85 percent of the GHG emissions in the United States. It is intended to allow EPA to collect accurate and timely emissions data to improve understanding of sources of GHG emissions and thereby support the future development of policies and programs to reduce GHG emissions.

Monitoring of GHG emissions is required to start on January 1, 2010, with the first reports due in 2011 for calendar year 2010. Facilities covered by the rule include industrial and commercial boilers that emit at least 25,000 tpy of GHGs. Determination of GHG emissions is either by direct measurement or facility-specific calculations. Facilities subject to the rule are required to submit annual reports to EPA, and reporting is to be completed on the facility-level, not on a system-wide or common-ownership level.

New Source Performance Standards

Administrator Jackson said EPA plans to reduce GHGs through NSPS to ensure only the most energy-efficient equipment is being installed. Unlike most other provisions of the CAA, EPA is required to determine whether a category of sources, not a specific pollutant, presents an endangerment to public health or welfare. Because EPA has made such findings for numerous source categories, some groups have argued that EPA is required to include GHGs as part of the set of pollutants EPA regulates from listed source categories.

The existing NSPS categories do not regulate GHGs. Consequently, should EPA seek to regulate GHGs using NSPS, small and insignificant GHG sources could become subject to performance requirements, leading to significant costs for boiler owners. Debate continues as to whether the NSPS program is sufficiently flexible and could support the implementation of market-based mechanisms for controlling GHG emissions. Yet, many questions remain unresolved, including how EPA, under an NSPS approach, would be able to avoid GHG regulation of categories it deems insignificant contributors of GHGs.

Startup, Shutdown, and Malfunction

In December 2008, the D.C. Circuit vacated the Startup, Shutdown, Malfunction (SSM) rules contained in the general provisions of the NESHAP, 40 C.F.R. Part 63. In particular, the court's decision vacated 40 C.F.R. § 63.6(f)(1) and (h)(1), which are two provisions in EPA's General Provisions Rule promulgated under Section 112 of the CAA that exempts sources from the requirements to comply with other applicable Section 112(d) emission standards during periods of startup, shutdown, and malfunction. *See Sierra Club v. EPA*, 551 F.3d. 1019 (D.C. Cir. 2008). The D.C. Circuit subsequently granted motions staying the mandate. Until the D.C. Circuit issues its mandate effectuating the vacatur, the SSM rules remain in effect.

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Pursuant to these rules, sources subject to a MACT standard were exempt from otherwise applicable emissions limits during SSM events. The SSM exemption was incorporated into the NESHAP regulations in 1994 because during periods of startup, shutdown, and malfunction it is technically impossible for the source to operate at 100 percent efficiency. To obtain the protections of the exemption, each source was required to develop a SSM plan to minimize emissions during such periods. The plan was then incorporated into the facility's Title V permit. With the promulgation of the 1994 exemption, EPA revised the SSM requirements, which included provisions that the SSM plan no longer had to be incorporated into the Title V permit.

A vacatur of the SSM exemption will have an impact on compliance and deviation reporting under Title V facility operating reports. Should the SSM exemption be vacated, to the extent such events produce emissions that exceed applicable permit limitations, a Title V facility must carefully evaluate how to report these events on their deviation and compliance certification reports. Further, industrial and commercial boiler operators will also need to evaluate how and when to report such events in their excess emission reports and will need to reevaluate how to comply with state malfunction reporting rules.

Emission-Control Strategies for Boilers

Central to the discussion of regulation of boiler air emissions is a strategy for pollution-control techniques for boilers. The technologies and methods described below are used to control fine particulate matter ($PM_{2.5}$), sulfur dioxide (SO_2), and nitrogen oxides (NO_x) emissions. The control options are divided into four categories: (1) fuel switching and fuel cleaning, (2) combustion-control technologies, (3) post-combustion control technologies, and (4) multipollutant control technologies. *See* STAPPA/ALAPCO, Controlling Fine Particulate Matter under the Clean Air Act (Mar. 2006).

Fuel switching encompasses several different control options. One option is blending lower-polluting fuels to reduce overall emissions. For example, many boiler operators blend lower-sulfur (sub-bituminous) coals with higher-sulfur (bituminous) coals to reduce SO_2 emissions. Another option is to substitute a lower-emitting fuel entirely. In some cases, fuel switching will have an impact on the performance of the boiler. If alternative fuels are available, retrofit costs are reasonable, and performance loss is manageable, then fuel prices will tend to be the determining factor in deciding whether fuel switching is viable. It is important to recognize that to maintain plant efficiency all areas of the plant must be evaluated for the effects of the change in fuels: fuel delivery, coal receiving and handling, burners, air heaters, heat transfer surfaces, auxiliary power, precipitators, ash-handling systems, environmental-control equipment and instruments, controls, and electrical equipment.

Coal washing is widely practiced in the United States to remove impurities and to increase the coal's heating value. Conventional coal-washing techniques remove ash and sulfur from coal by crushing the fuel and separating the different components in a liquid bath, such as water. The lighter coal particles float to the top of the bath for recovery, while the heavier impurities sink to the bottom for removal. The cost of coal cleaning varies depending on the type of coal and is offset by reduced ash-disposal requirements, increased generation per ton of coal, reduced SO_2 and PM emissions, decreased transportation costs, reduced equipment wear and tear, and lower operating and maintenance costs.

Combustion controls attempt to suppress the formation of NO_x within the boiler by controlling peak flame temperatures, oxygen concentrations, and residence times in the active combustion zones; however, only a small percentage of industrial boilers have combustion controls. The most common technologies are low-NO_x burners (LNBs) and overfire air (OFA). Low-NO_x burners can be combined with OFA, reburning, or flue gas recirculation. Low-NO_x burners are designed to control fuel and air mixing at each burner to create larger and more branched flames, thereby reducing peak flame temperature and resulting in less NO_x formation. The improved flame structure also reduces the amount of oxygen available in the hottest part of the flame, thus improving burner efficiency.

Post-combustion controls are pollution-control devices that are placed downstream of the boiler to remove pollutants from the flue gases. Post-combustion controls are effective at removing PM (including $PM_{2.5}$), SO_2, and NO_x. A fabric filter, commonly called a baghouse, traps particulates in the flue gas before they exit the stack. Fabric filters are made of a woven or felted material in the shape of a cylindrical bag or a flat, supported envelope. The system includes a dust-collection hopper and a cleaning mechanism for periodic removal of the particulates.

Over the past several years, the development of new filter media and special coating and finishing techniques has extended the life and improved the performance of fabric filters. Modern computer controls continuously monitor and adjust the cleaning process, improving emissions control and lowering costs. An electrostatic precipitator (ESP) uses an electrical charge to separate the particles in the flue gas stream under the influence of an electric field. An ESP works by imparting a positive or negative charge to particles in the flue gas stream. The particles are then attracted to an oppositely charged plate or tube and removed from the collection surface to a hopper by vibrating or rapping the collection surface. Wet scrubbers are also used to control particulate emissions.

Flue gas desulfurization (FGD) uses a sorbent—usually lime or limestone—to remove SO_2 from the exhaust gases of a fossil-fuel-fired boiler. FGD scrubbers can be wet or spray dry and can be used on coal-fired industrial boilers. FGD scrubbers are capable of reduction efficiencies ranging from 50 percent to 98 percent. Historically, wet FGD scrubbers have the highest removal efficiencies (greater than 90 percent), while dry FGD scrubbers have the lowest.

Newer dry scrubbers are capable of efficiencies near 90 percent. Dry sorbent injection involves the direct release of sorbents, typically lime, into the ductwork or boiler upstream of a PM-control device. The SO_2 in the flue gas reacts with the powdered sorbent, which can then be collected by the downstream PM-control device. The SO_2 control efficiency of existing dry injection systems ranges from 40 to 60 percent when using lime or limestone and up to 90 percent using other sorbents such as sodium bicarbonate.

Selective catalytic reduction (SCR) is a well-developed and widely applied postcombustion NO_x-control technology. SCR reduces NO_x emissions using a reducing agent and a catalyst. EPA estimates a NO_x control effectiveness of 80 to 95 percent for industrial boilers. *See* EPA, Cost of Selective Catalytic Reduction (SCR) Application for NO_x Control on Coal-fired Boilers, EPA/600/SR-01/087 (Jan. 2002). The main factors in determining the emissions reduction potential of this technology are temperature, the amount of reducing agent, injection grid design, and catalyst activity.

Selective noncatalytic reduction (SNCR) is a postcombustion NO_x control technology that has been installed on a wide range of boiler configurations. In SNCR systems, a reagent is injected into the flue gas of the boiler within an appropriate temperature window. The NO_x and reagent (ammonia or urea) react to form nitrogen and water. A typical SNCR system consists of reagent storage, multilevel reagent-injection equipment, and associated control instrumentation. The SNCR reagent storage and handling systems are similar to those for SCR systems. However, because of higher stoichiometric ratios, both ammonia and urea SNCR processes require three or four times as much reagent as SCR systems to achieve similar NO_x reductions.

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There are hundreds of SNCR systems installed in the United States on boilers ranging in size from 50 MMBtu/hr to 6,000 MMBtu/hr. SNCR operating alone has a NO_x reduction potential of 30 to 70 percent. According to EPA, SNCR combined with other controls, such as LNBs, can achieve reductions of 65 to 75 percent.

Control-technology manufacturers are developing a new generation of multipollutant controls designed to capture multiple air pollutants more cost effectively than existing single-pollutant controls. In addition to better performance and reduced cost, multipollutant control technologies can offer the following benefits: fewer system components, reduced space requirements, and reduced operational complexity; lower auxiliary power requirements, resulting in improved efficiency of a unit; lower collateral emissions; and reduced water consumption, wastewater discharge, and solid waste.

The world of environmental regulation of industrial and commercial boilers has changed dramatically in the past year. The challenge for the owners of commercial and industrial boilers in the coming years will be to develop a strategy for compliance that is consistent with the financial realities of the entities being regulated.