

MEMORANDUM

Date: November 16, 2012

Subject: Startup and shutdown provisions

From: William Maxwell, ESG/SPPD/OAQPS

To: EPA-HQ-OAR-2009-0234

The Administrator signed the “National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units,” comprising the NESHAP portion, known as the Mercury and Air Toxics Standards (MATS) and the Utility NSPS, on December 16, 2011, and the final rules were published in the Federal Register on February 16, 2012 (see 77 FR 9304). We proposed different standards for startup and shutdown by our inclusion of certain default values, which applied only during startup and shutdown.

In response to comments on the proposed rule, we finalized work practice standards to apply during startup and shutdown, as described further below. This technical support document describes the provisions for startup and shutdown promulgated in the final rule¹ and changes to these provisions to address issues raised in the petitions for reconsideration of the final MATS rule and the Utility NSPS.

I. MATS Proposed Rule

In the final rule, we proposed different standards for startup and shutdown by our inclusion of the default values described below, which applied only during startup and shutdown. Specifically, we stated:

To appropriately determine emissions during startup and shutdown and account for those emissions in assessing compliance with the proposed emission standards, we propose use of a default diluent value of 10.0 percent O₂ or the corresponding fuel specific CO₂ concentration for calculating emissions in units of lb/MMBtu or lb/TBtu during startup or shutdown periods. For calculating emissions in units of lb/MWh or lb/GWh, we propose source owners use an electrical production rate of 5 percent of rated capacity during periods of startup or shutdown. We recognize that there are other approaches for determining emissions during periods of startup and shutdown, and we request comment on

¹ This document uses the terms “the final rule” and “the rule” to refer to MATS, though the Utility NSPS incorporates these same provisions with regard to the particulate matter standard for that rule.

those approaches. We further solicit comment on the proposed approach described above and whether the values we are proposing are appropriate.

We proposed application of the respective emission limits during periods of startup and shutdown and use of default values to calculate the emission limits. The standards that apply at all times other than startup and shutdown are production-based limits, which is why we proposed the default values. The default values were meant to account for the fact that during startup and shutdown events, production (in this case the generation of electricity) is by definition nonexistent.

We received a variety of comments on the proposed rule concerning the application of the standards during startup and shutdown. Many commenters pointed to the lack of data in the record concerning emissions that occur during periods of startup and shutdown. Commenters also asserted that emissions during these periods can vary widely during the startup and shutdown of an EGU. Other commenters questioned the feasibility of collecting additional data during such periods and voiced concerns regarding the reliability of measurements obtained from EGUs during such periods.

II. Final Rule

In response to comments, we established work practice standards rather than numeric emissions standards for periods of startup and shutdown in the final MATS rule. See 77 FR 9380-82.

The final rule required the owners and operators of EGUs to: (1) operate using “clean fuels,” which were listed as either natural gas or distillate oil, or a combination of those, for ignition during startup, (2) vent emissions to the main stack(s) and operate all control devices necessary to meet the normal operating standards under the final rule, with the exception of those technologies whose operation is temperature-dependent, when coal, solid oil-derived fuel, or residual oil is fired in the EGU during startup or shutdown, and (3) start their temperature-dependent control systems appropriately to comply with relevant standards applicable during normal operation.

In the proposed reconsideration notice, the Agency is proposing work practice standards that are substantially the same as the work practice standards established in the final MATS. Specifically, sources must combust clean fuels during periods of startup and shutdown, and coal and oil may not be combusted in the EGU until certain air pollution controls are engaged. The EPA is, however, proposing to revise the definitions of “startup” and “shutdown,” to add a definition of “clean fuel” and expand the list of “clean fuels,” and to revise requirements related to the operation of controls.

A. Definitions

We first address what constitutes startup and shutdown because definitions of these periods are essential to implementation of work practice standards.

1. Startup and Shutdown Periods

In the final rule, we included the following definitions of startup and shutdown:

Startup means either the first-ever firing of fuel in a boiler for the purpose of producing electricity, or the firing of fuel in a boiler after a shutdown event for any purpose. Startup ends when any of the steam from the boiler is used to generate electricity for sale over the grid or for any other purpose (including on site use).

Shutdown means the cessation of operation of a boiler for any purpose. Shutdown begins either when none of the steam from the boiler is used to generate electricity for sale over the grid or for any other purpose (including on-site use) or at the point of no fuel is being fired in the boiler. Shutdown ends when there is both no electricity being generated and no fuel being fired in the boiler.

Petitioners sought clarification regarding these terms as applied to EGUs and stated that the definitions should be revised to accommodate the operation of cogeneration units, and did not accurately reflect startup conditions for all affected units, particularly supercritical units. We are proposing to revise the definitions in this reconsideration notice as follows:

Startup means the period in which operation of an EGU is initiated for any purpose. Startup begins with either the first-ever firing of fuel in an EGU for the purpose of producing electricity or useful thermal energy (such as heat or steam) for industrial, commercial, heating, or cooling purposes, or the firing of fuel for any purpose in an EGU after a shutdown event. Startup ends when the EGU generates electricity that is sold or used for any other purpose (including on site use), or the EGU makes useful thermal energy (such as heat or steam) for industrial, commercial, heating, or cooling purposes (16 U.S.C. 796(18)(A) and 18 CFR 292.202(c)), whichever is earlier.

Shutdown means the period in which cessation of operation of an EGU is initiated for any purpose. Shutdown begins when the EGU no longer generates electricity or makes useful thermal energy (such as heat or steam) for industrial, commercial, heating, or cooling purposes; or when no coal, liquid oil, syngas, or solid oil-derived fuel is being fired in the EGU, whichever is earlier. Shutdown ends when the EGU no longer generates electricity or makes useful thermal energy (such as steam or heat) for industrial, commercial, heating, or cooling purposes, and no fuel is being fired in the boiler.

We maintain that the proposed revised definitions, including the addition of provisions for useful thermal energy,² appropriately address the fact that EGUs can provide electricity both for sale and for on-site use, and cogeneration EGUs can also supply useful thermal energy (such as heat or steam) for industrial, commercial, heating, or cooling purposes. For this reason, we believe that EGUs should be considered to be operating normally at all times electricity is generated for sale or use, and/or useful thermal energy (such as heat or steam) is supplied for a useful purpose.

Some petitioners have asserted that, by definition, a supercritical EGU can only achieve its normal operating conditions once the steam reaches supercritical conditions. Because this process requires transition from “subcritical” to “supercritical” conditions, a supercritical EGU has a dedicated startup system to separate steam from water until the unit reaches operating conditions at approximately 30 to 40 percent of full load. Through this comment, the petitioners seem to suggest that for supercritical EGUs the startup period ends only after the steam sent to the turbine has no water droplets, which, according to the petitioners, happens at approximately 30 to 40 percent load.

We believe our proposed revised definition of startup accounts for the operation of supercritical EGUs. Under the revised definition, the startup period begins with firing of clean fuel and ends with generation of electricity for any useful purpose or production of useful thermal energy (such as steam or heat), whichever comes first. Separation of steam and water, irrespective of the EGU type – subcritical or supercritical – occurs within this period.³

Some petitioners asserted that the definition of startup period and the work practices in the final rule are not accurate because startup extends beyond first generation of electricity, because electricity generation does not mean that the EGU and emission controls have reached a safe or stable normal operating condition, because the concept of minimum stable load (at which point supplemental fuel is not needed) is relevant relative to efficient, stable, and safe operation of air pollution controls, and because operation of all control equipment should be tied to the end of the startup in the revised definition. As discussed below, we believe both the proposed revised definitions of startup and shutdown periods and the proposed revised work practices, which take into consideration potential operational constraints of air pollution control devices (APCDs), address these concerns.

Per our proposed definition of startup period, this period ends when an EGU generates electricity that is sold or used for any other purpose (including on-site use) or an EGU makes useful thermal energy (such as heat or steam) for industrial, commercial, heating, or cooling purposes, whichever is earlier. We disagree that the startup period extends beyond first generation of useful electricity, as we believe EGUs are operating in production (not startup) mode when they

² 16 U.S.C. 796(18)(A) and 18 CFR 292.202(c).

³ We understand that a steam turbine should not be exposed to water droplets at its inlet at any load, to prevent blade erosion and other problems, and that boiler/turbine systems are designed to prevent this, and we do not consider the proposed definition to be problematic in this regard.

generate electricity or produce thermal energy for use.

We also believe that the proposed APCD operation-related work practice requirements accommodate efficient, safe, and stable operation. Moreover, we have carefully designed our definitions and work practice requirements to provide flexibility to EGU owners/operators regarding operation of controls, and therefore we have not tied operation of these more condition-specific controls to loads or specific points in the startup period. We also understand that no technical barrier exists to burning clean fuels for longer portions of startup or shutdown periods. Hence, if needed, an EGU could burn clean fuels until the appropriate flue gas conditions are achieved to engage the required APCDs.

While petitioners suggest that the concept of minimum stable load (at which point supplemental fuel is not needed) is relevant relative to efficient, stable, and safe operation of air pollution controls, they have not provided data supporting this claim. Moreover, if an EGU co-fires clean fuels with production fuels (coal, liquid oil, syngas, or solid oil-derived fuel) after the end of its startup period, its emissions will be lower than those generated when it fires only production fuels. Considering these factors, the EPA is not taking any actions relative to the concept of minimum stable load asserted by petitioners.

2. Clean Fuels

The final rule required use of “clean fuels,” listed as either natural gas or distillate oil, or a combination of those, for ignition during startup. Petitioners asserted that the finalized work practice standards should include synthetic natural gas, syngas, and ultra-low sulfur diesel (ULSD) as “clean fuels.” Specifically, petitioners referred to the use of synthetic natural gas or diesel fuel for some EGUs and syngas for startup of integrated gasification combined cycle (IGCC) EGUs affected by this rule. The EPA also understands that propane is used for startup at some EGUs.

In the proposed reconsideration rule, we have proposed adding a definition of “clean fuels” and including synthetic natural gas that meets the specification necessary for that gas to be transported in/via a Federal Energy Regulatory Commission-regulated pipeline, synthesis gas (syngas)⁴, propane, and ultra-low sulfur diesel (ULSD) to the list of clean fuels noted in the final rule (natural gas and distillate oil). We believe that HAP emission reduction benefits associated with burning of clean fuels warrant utilization of such fuels during startup and shutdown periods. We also note that addition of synthetic natural gas to the list of clean fuels provides the opportunity for conventional coal-fired EGUs to startup on synthetic natural gas if desired. Also, limiting the diesel fuel to the ULSD type will help minimize emissions during period of startup and shutdown.

⁴ Synthesis gas (syngas) is gasifier product gas consisting mostly of hydrogen and carbon monoxide.

The proposed definition is below.

Clean fuel means natural gas, synthetic natural gas that meets the specification necessary for that gas to be transported on a Federal Energy Regulatory Commission (FERC) regulated pipeline, propane, distillate oil, synthesis gas (syngas), or ultra-low-sulfur diesel (ULSD).

B. Operation During Startup and Shutdown

In the final rule, the EPA required sources to vent emissions to the main stack(s) and operate all control devices necessary to meet the operating standards that apply at all other times under the final rule (with the exception of dry scrubbers and selective catalytic reduction (SCR) systems) when coal, solid oil-derived fuel, or residual oil is fired in the EGU during startup or shutdown. The EPA stated that it is the responsibility of the operators of EGUs to start their dry scrubber and SCR systems appropriately to comply with relevant standards applicable during normal operation.

Petitioners stated that IGCC EGUs are fired with syngas, not the fuels listed as “clean fuels” in the final rule. Petitioners also contended that the standards need to recognize operating conditions for fluidized bed combustion (FBC) EGUs that inject limestone for acid gas control, for most effective control of those gases, as well as operating conditions for selective non-catalytic reduction systems (SNCRs), selective catalytic reduction systems (SCRs), and other systems. We have considered these concerns, and in the proposed reconsideration notice are proposing to require EGU source owners or operators, when firing coal, solid oil-derived fuel, or residual oil in the EGU during startup and shutdown, to vent emissions to the main stack(s) and operate all control devices necessary to meet the operating standards that apply at all other times under the final rule (with the exception of limestone injection in FBC EGUs, dry scrubbers, SNCRs, and SCR). Owners and operators of EGUs are responsible for starting limestone injection in FBC EGUs, dry scrubber, SNCR, and SCR systems as expeditiously as possible, but, in any case, when necessary to comply with other standards applicable to the source that require operation of the control devices.

1. IGCC Units

The EPA understands that at IGCC EGUs, syngas (primarily a mixture of carbon monoxide and hydrogen) is used as both a clean fuel and the production fuel. We understand that syngas is generated in the gasifier of an IGCC EGU and after the syngas achieves the desired site-specific composition, it is fired in the combustion turbine as a clean and production fuel. The syngas fired in the combustion turbine is considered a clean fuel because it is cleaned to remove trace contaminants such as sulfur before its injection in the turbine. We also understand that during the startup and shutdown periods, some or all of the syngas produced may not be combusted in the turbine. In the proposed reconsideration rule, we are proposing two options for IGCC EGUs for handling syngas not fired in the combustion turbine: (1) syngas must be flared, not vented, or (2)

syngas must be routed to duct burners, which may need to be installed, and the flue gas from the duct burners must be routed to the heat recovery steam generator.

2. Operating Constraints of Certain APCDs

In the proposed reconsideration rule, we also propose to revise the rule's work practice requirements to recognize constraints of certain EGUs and APCDs. Specifically, after considering petitions that FBC EGUs that inject limestone for acid gas control need to be operated at temperatures at which limestone can calcine for most effective control of acid gases⁵, we are proposing to revise the standards to allow limestone injection to start after appropriate temperatures as specified by the equipment manufacturer or installer have been attained in such EGUs. In addition, we acknowledge operating temperature constraints of SNCR systems, and we are proposing to revise the standards to allow such systems to start as soon as technically possible after the appropriate temperatures as specified by the equipment manufacturer or installer have been reached. We are also aware that SNCR and SCR systems with ammonia injection need to be operated within a prescribed and relatively narrow temperature window to provide nitrogen oxide (NO_x) reductions⁶ and that dry scrubbers also need to be operated close to flue gas saturation temperature⁷, and we have addressed these considerations in the proposed work practice requirements.

Some petitioners have asserted that premature use of ACI, as well as trona and other alkaline sorbents that are heavier than activated carbon, can lead to deposits on particular matter (PM) control surfaces and potentially cause detrimental impacts on hardware and operation of these controls and create safety concerns, including fires. Petitioners suggested that sorbent use can only begin when a sufficiently high gas flow rate is achieved in the duct. The EPA has reviewed publicly available information and information submitted in comments to the rule, and we have not found any information supporting the petitioners' assertions. Moreover, petitioners have not provided data substantiating their assertions. Therefore, we are not adding specific work practice requirements associated with sorbent (carbon or trona or other alkaline materials) injection.

Further, as discussed in the preamble to the final rule, we understand that there may be concerns with acidic and tarry deposits on surfaces of PM controls (ESPs and baghouses) related to firing of heavy (residual) oil, but that such concerns do not exist when EGUs combust light (distillate) oil.⁸ Accordingly, with residual fuel oil firing, site-specific flue gas temperature and oxygen (O₂)

⁵ Fluidized Bed Combustion. Simeon Oka, CRC Press, September 2003, pp. 527-528.

⁶ NO_x Emission Control Options For Coal-Fired Electric Utility Boilers. R.K. Srivastava, R.E. Hall, S. Khan, K. Culligan, and B. Lani, Journal of the Air & Waste Management Association, 55, September 2005, pp. 1372-1374.

⁷ Flue Gas Desulfurization: The State of the Art. R.K. Srivastava and W. Jozewicz, Journal of the Air & Waste Management Association, 51, December 2001, p. 1680.

⁸ Coal is fired at sufficiently high temperatures that concerns with condensation causing acidic and tarry deposits are not relevant.

concentration thresholds may be relevant to minimize condensation of acids and tars and thereby minimize any potential for detrimental impacts on hardware and any safety concerns. The rule's proposed work practice requirements provide flexibility to the operator to take appropriate site-specific remedial measures, if needed, to address this issue. EGU owners or operators have several options to prevent detrimental impacts: (1) using clean startup fuels (e.g., natural gas, synthetic natural gas, syngas, ULSD, or distillate oil) until appropriate flue gas conditions have been reached and then subsequently switching to firing of residual oil; (2) pre-coating the PM control surfaces⁹ with an alkaline powder (e.g., limestone); (3) installing chemically resistant bags¹⁰ in fabric filters (FF)s if applicable, or (4) using low-sulfur oils.

The EPA also notes that there are currently many operational residual oil-fired EGUs that are started up with either natural gas or distillate oil. At these EGUs, the transition from the startup fuel, distillate oil or natural gas, to residual oil is already being practiced without unacceptable impacts on APCDs, including PM controls that are operated to meet applicable opacity limits. Based on this experience and the options described above, those EGUs where residual oil is used for either a part of the startup period or as the main fuel will also be able to operate their PM controls to meet the rule's work practice requirements.

We are not aware of any operational constraints applicable to operation of wet scrubbers during startup that could cause detrimental impacts on wet scrubber hardware or could create safety concerns, and we did not receive comments on this aspect of wet scrubber operation.

We also note that dry sorbent injection (DSI) can be applied across a very broad temperature range and will be engaged when residual oil or coal is fired in an EGU if necessary to comply with HCl requirements. Again, we did not receive comments on this aspect of DSI operation.

In summary, based on the discussion above, we believe there are no constraints with engaging PM controls (ESPs and baghouses), wet scrubbers, and sorbent injection systems (ACI and DSI) when firing coal, solid oil-derived fuel, or residual oil in EGUs during startup and shutdown. Owners and operators of EGUs are responsible for starting limestone injection in FBC EGUs, dry scrubber, SNCR, and SCR systems as expeditiously as possible, but, in any case, when necessary to comply with other standards applicable to the source that require operation of the control devices.

⁹ Coal Power, May 1, 2007: http://www.coalpowermag.com/plant_design/Coal-Plant-O-and-M-River-Locks-and-Barges-Are-an-Aging-Workforce-Too_36.html

¹⁰ Neundorfer: Lesson #4, p.4-7, Table 4-1:

[http://www.neundorfer.com/FileUploads/CMSFiles/Fabric%20Filter%20Material\[0\].pdf](http://www.neundorfer.com/FileUploads/CMSFiles/Fabric%20Filter%20Material[0].pdf)