Testimony of
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"Factors Affecting the Timeline for Retrofit of Environmental Control Technologies to Coal-fired Power Stations"

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SUMMARY

The U.S. Environmental Protection Agency (EPA) states that planning, designing, and constructing state-of-art emission control systems can be accomplished in less than 30 months. EPA made such claims when publishing its Cross State Air Pollution Rule (CSAPR) this summer and when proposing National Emissions Standards for Hazardous Air Pollutants for electric generating units (the Utility MACT proposal) last spring.

Contrary to EPA's claims, however, the "start to finish" times for this equipment – flue gas desulfurization (FGD) "scrubbers" to reduce sulfur dioxide (SO_2); selective catalytic reduction (SCR) catalytic reactors to reduce nitrogen oxides (NO_x); and fabric filters to remove particulate matter – will be much more than 30 months. The most recent experience shows retrofits of FGD and SCR systems will typically take between 40 and 50 months.

There are two key reasons why it takes this long to plan, permit, fabricate, and install these control systems. First, the equipment is large, and must be configured to fit into often-crowded plant sites. Second, these are not off-the-shelf designs; each must be custom-tailored to the site and coal. The problems are compounded when several control technologies are retrofit simultaneously at one plant site. For example, in order to comply with the CSAPR and the Utility MACT rule as proposed, owners may need to install FGD scrubbers and SCR catalytic converters at their plant sites at about the same time they are installing fabric filters to reduce mercury and other pollutants targeted by the proposed Utility MACT rule.

Few "short cuts" are available to significantly reduce this schedule by more than a few months. I do not concur with EPA's statement in the CSAPR rulemaking that years can be carved off the "start-to-finish" times of FGD and SCR systems by fast-tracking design and procurement processes. And there is a downside to fast-

tracking these kinds of projects: it could compromise the quality of design or construction of the equipment, forcing plant operators for decades to use control systems that are ill-suited or otherwise not optimal for their sites.

Similarly, EPA has no basis to predicate the feasibility of its very tight Utility MACT compliance deadlines on principally one methodology: injecting specially prepared powders or sorbents into power plant gas streams to remove mercury and other pollutants such as hydrogen chloride. These sorbents will work in some instances, but not across the board as envisioned by EPA to achieve the targeted reductions. And where the use of sorbents does <u>not</u> achieve the very low emission limits proposed by EPA, owners will have to retrofit fabric filters to meet the proposed Utility MACT rule. EPA predicts as much as half of the generating inventory in the U.S. will have to do so. Under the best of circumstances, it would be difficult (if not impossible) to retrofit fabric filter controls at so many sites, in the short MACT compliance timeframe. The challenge becomes even greater, though, if owners must install fabric filters at roughly the same time they are installing FGD and SCR systems to comply with the CSAPR.

INTRODUCTION

Chairman Hall, Ranking member Johnson, and members of the Subcommittee, thank you for the opportunity to speak with you today. I will provide an overview of the factors that affect the retrofit of environmental control technologies to coal-fired power stations, for the purpose of meeting the mandates of the Cross State Air Pollution Rule (CSAPR) and the National Emissions Standards for Hazardous Air Pollutants (i.e., Utility MACT), particularly factors that influence the timing of installation.

The power industry in the last ten years has successfully retrofit state-of-art environmental controls to a large fraction of generating units. Consequently, much of the power delivered into today's markets is generated by units equipped with effective environmental controls. The industry will continue to strive to meet future environmental mandates. However, as I will describe, the type of equipment that must be retrofit is exceedingly large in size, can be very complex, and can require special engineering and preparation tasks. To do this right simply takes time. Further, we have learned from experience what happens when the design or fabrication of a control technology is rushed, or is not optimized or properly designed for a given site and fuel. The outcome is never good.

Based on my years of experience advising power generation equipment owners in the retrofit of environmental control technology, I believe that typically between 40 and 50 months will be required to retrofit control options to meet the mandates of the CSAPR and the Utility MACT. It may be possible to reduce a few months from the schedule by fast-tracking design and procurement, and using so-called "lean" construction methods, but in general it will not be possible to achieve this outcome in less than 30 months. Further, a result of fast-tracking these duties could be a compromise in the quality of design or construction of this equipment. Operators would be forced for decades to use equipment that is not optimal for the site, or otherwise ill-suited.

DESCRIPTION OF ENVIRONMENTAL CONTROLS

The industry selects from a suite of environmental controls those appropriate for a given task: removing sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter, and trace species commonly referred to as hazardous air pollutants (HAPS). HAPS include mercury and acid gases such as hydrogen chloride. There are two distinguishing features of environmental controls for power plant effluent gases – first, the equipment is very large, and second there is no one-size-fits all design. Most equipment represents a custom design tailored to the characteristics of a particular site, and coal.

Exhibits 1–3 depict three of the key control technologies utilized. Exhibit 1 depicts a flue gas desulfurization (FGD) process that removes SO_2. Exhibit 2 depicts a selective catalytic reduction (SCR) module to reduce NO_x; this module is basically a catalytic converter for a power station. Exhibit 3 depicts a fabric filter or baghouse, which filters out particulate matter. As will be discussed subsequently, the fabric filter device is important not only to control particulate matter, but also to contribute to limiting emissions of HAPS. Each of Exhibits 1–3 is meant to convey the large equipment size that is necessary to process the volume of gaseous combustion products. The equipment must be of large flow cross-section to reduce the velocity or speed of the gas to very low levels, to allow mixing of chemical reagents, and to provide time for reactions to take place to completion. For example, the speed of the gas in the FGD absorber tower is typically 5-10 feet per second – or about 3-7 mph – necessitating a large reactor.

The vessel size becomes problematic when it must be fit into an existing crowded site. It is the challenge of fitting these vessels into crowded sites, all of which differ in almost limitless ways, which can require a protracted design and installation effort. Exhibit 4 presents a plant layout – in my opinion of intermediate difficulty – containing this equipment, showing how environmental controls can be arranged. Some sites can be open and offer less challenge, but a notable number of units will face space limits.

In summary, the retrofit of environmental controls – all utilizing large vessels or reaction chambers, some with chemical and byproduct support plants – requires custom design, shop fabrication, and installation that take a lot of time.

TIMELINE FOR EQUIPMENT INSTALLATION

The “start-to-end” timeline to install these control systems includes many steps, above and beyond just the work to prepare a detailed design and install the equipment. A discussion of the key steps required, and a summary of recent experience is insightful. A detailed description of the key steps, and recent relevant experience, is presented in a report submitted to EPA on October 1, 2010, (a copy of which is attached to these comments), as part of comments to the rulemaking process. I'll summarize both topics.

Ten Steps: Project Initiation to Completion

The complete scope of activities to retrofit environmental controls can require as many as ten separate steps, each of which will vary by project. Several of these steps can be conducted in parallel, but most require some sequence – at least some portion of one activity must be completed before the next is started. The ten steps, including the range of time (in months) for execution, are:

<u>Conceptual Design, and Preparing a Specification</u>. What you want to build must be described in a way bidders can use to derive a design (6-12 months).

<u>Identification of Qualified Bidders</u>. Potential contractors are to be identified; this process is typically conducted in parallel with the preceding (1 month).

<u>Solicitation and Review of Bids, and Contractor Selection</u>. On-site "walkdowns" are essential to acquaint bidders with the project. Evaluating capabilities is key; cost alone is not the determining factor in contractor selection (3-5 months).

<u>Negotiating Contract Terms and Conditions</u>. Acceptable terms and conditions for labor and material, including escalation, are negotiated in advance (1-5 months).

<u>Securing Construction, Operating Permits</u>. Permits – issued by local regulatory agencies and public utilities commissions – are required before construction can begin. Some preliminary design must be completed to define equipment and estimate emissions. Opening a storage site for byproduct material is most challenging (4 months to 4 years).

<u>Finalizing Design</u>. Producing engineering drawings is key, with detailed estimates of media emissions, to enable equipment purchase and fabrication (15-45 months).

<u>Mobilizing the Workforce</u>. Identifying and securing the services of the mobile, specialized workforce has been rate-limiting for some projects (1-3 months).

<u>Construction.</u> Includes soil, foundation, and structural preparatory work; fabricating, transporting, and erecting equipment. This is the most protracted on-site activity (25-40 months)

<u>Process Tie-In</u> (1-3 months) and <u>Process Start-Up</u> (1-3 months) are the final steps.

Each of these steps is essential, although some can be expeditiously conducted depending on the site. For example, where an owner has negotiated a long-term strategic agreement with one supplier, the steps of contractor selection, evaluation, and contract negotiation for any project may take less time. However, getting the long-term agreement in place at the start is a lengthy process.

Projected timelines that do not consider each of these steps may not reflect the true "start" date, and will not be accurate.

Recent Experience and Lessons Learned

The power industry, working with the community of equipment suppliers, has extensive experience retrofitting environmental control technology to generating units. Most recently, a significant fraction of the generating inventory was retrofit with FGD scrubbers and SCR catalytic converters over the time period of 2008 through 2010. Specifically, a total of 123 generating units were retrofit with FGD, and a total of 40 units were retrofit with SCR catalytic converters, from 2008 through 2010.

During the past two years, I have been involved with or had the opportunity to review retrofit projects for 22 FGD scrubbers and 14 SCR catalytic converters. As I described in the previously referenced October 1, 2010 report that was submitted to EPA, the time required to execute each retrofit – from "start-to-finish" – varied between units and sites. For FGD retrofits, completing all duties for the least complex projects – those that retrofit a single FGD process at a single site – took from 40 to 64 months, with the average of projects being 48 months. The shortest of these schedules – 40 months – was incurred for a unit that applied the process design from a near-identical "sister" unit, and was able to construct several critical facilities in parallel. The retrofit of multiple FGD equipment to more complex sites can require more time.

For SCR catalytic converters, the complete scope of duties for the least complex projects required from 28 to 46 months, with an intermediate project taking 40 months. The shortest of these schedules – 28 months – was achieved as the subject unit was on the "end" of a row, providing improved access for cranes and other heavy fabrication equipment. Similar to FGD, the retrofit of SCR equipment to more complex sites with multiple units requires more time, up to 60 months.

Some within EPA appear to agree it will typically take more than 21 (or even 30) months to install SCR. In an unrelated rulemaking to establish Best Available Retrofit Technology (BART) to limit NO_x emissions from the San Juan Generating Station (SJGS) in New Mexico, EPA determined recently (on August 22, 2011), that on average it takes 37 months to retrofit an SCR system on an existing unit. And EPA determined that it would be reasonable for the owners of SJGS to have five years to undertake and complete the SCR retrofit at SJGS.

In summary, under the best conditions, an FGD scrubber with require at least 40 months to retrofit, with most applications between 40 and 50 months. For SCR, under the best conditions an SCR catalytic reactor will require 28 months, with most applications averaging 44 months.

COMPLIANCE TIMING: "LOGJAM" OF EVENTS 2012 TO 2015

The emissions reductions provisions of the CSAPR and the Utility MACT require control technologies to be installed and operational at almost the same time – January 1 of 2014 for the CSAPR, and January 1 of 2015 for the Utility MACT rule. Given the time required to prudently design and install control equipment, it is not possible for operators affected by these regulations to meet these deadlines. This becomes clear with a further elaboration of the needs of each mandate.

2014 Mandates of the Cross State Air Pollutant Rule (CSAPR)

The CSAPR requires affected companies in the so-called "Group 1" states to achieve the mandated SO_2 reductions by January 1 of 2014. The amount of generating capacity, and the number of FGD scrubbers that need to be installed to achieve this compliance, has been projected by EPA as part of the Agency's analysis in support of the rule.

EPA's initial estimates of technology retrofit for the CSAPR, as first published in 2010, projected that 85 units generating 25 GW of capacity would retrofit FGD to comply with the 2014 mandate. In the final proposal for the CSAPR in July of 2011, EPA revised downward the estimates of FGD to 39 units generating 17.4 GW of capacity. The basis of EPA's downward revision appears to be a consequence of altering the modeling details and lowering the projected load growth. Based on the typical FGD "start-to-finish" scope discussed of 40 to 50 months, any owners that must comply would already have had to start – and in fact should be more than one year into these efforts. Given the date of the final release of the CSAPR – less than 60 days ago on July 7 of 2010 – the timing presumes owners started engineering well in advance of finalizing EPA's rule.

EPA's rationale in proposing the 2014 date is not only that a 27 month timeline is typical for FGD, but also that owners can start work without risk prior to the promulgation of a final regulation. This is not the case. Historically, there have been instances where owners have quickly and proactively responded to a pending rule, only to witness the rule being changed or delayed. As a result, construction is terminated, or acquired SO_2 allowances cannot be utilized. The owner must absorb any "sunk" costs for equipment or allowance purchase.

2015 Mandates of the Utility MACT Rule

Perhaps more challenging is the schedule presented by the National Emissions Standards for Hazardous Air Pollutants (NESCHAPS) – the Utility MACT mandate.

Compliance strategies for this proposed rule – scheduled to be finalized by the end of this year– are uncertain. The control technologies discussed in this testimony so far – the FGD scrubber, the SCR catalytic converter, and the fabric filter – can contribute in ways both large and small to MACT compliance. Owners of generating units are investigating how to best utilize these technologies for MACT, recognizing the degree of control required for both mercury and hydrogen chloride is at or beyond the capabilities of these controls in most applications.

However, EPA is predicating success – timely compliance with the MACT – based principally on one methodology. This method entails injecting into the gas one or more specialty powder(s), referred to as sorbents, to remove mercury and hydrogen chloride. One class of sorbents, known as activated carbon, is intended to remove mercury from combustion products. A second class of sorbents – actually a family of materials derived from the mineral trona – is intended to remove acid gases, such as hydrogen chloride. EPA believes any shortcomings in sorbent performance can be compensated by retrofitting fabric filters to 166 GW of capacity – more than half of the national inventory of units in 2015.

Regarding mercury, experience with activated carbon in demonstration tests suggests this sorbent will be successful on many units. However, as noted in an August 2011 report addressing mercury control technology (a copy of which is attached to this testimony) for the proposed Utility MACT rule, there may be an equal population of units that will not meet the targeted mercury limit. There may also be units where the carbon sorbent induces operating problems, or increases the emissions of particulate matter.

Regarding control of “acid gases” such as hydrogen chloride, the uncertainty is far greater. EPA, to its credit, developed an extensive database of emissions of HAPS species from power generation equipment. Regrettably, certain elements of the database were either ignored or not properly utilized. EPA’s proposed hydrogen chloride limits presume that sodium sorbents can be a sole means to comply – despite the fact that of the 11 units in EPA’s database using this approach, there are only 2 units with data suggesting such success. EPA predicted in a March 17, 2011, document that 56 GW of capacity would deploy this sodium-based sorbent approach. It is hard to believe the design for so many commercial systems can be successfully scaled, and equipment installed, on such limited experience.

For both the mercury and hydrogen chloride MACT mandates, EPA’s “backstop” approach is broad application of fabric filters to 166 GW of capacity. Again, it is hard to believe that such capacity can be retrofit with both sorbent injection systems and fabric filters, and successfully operate as predicted, in slightly more than 3 years. Furthermore, the proposed fabric filter retrofits are to be achieved at the same time the technologies for CSAPR are being deployed. Such a schedule would stretch supply sources in 2013, and in my opinion well into 2014 as the FGD units are delayed. Although the task of installing any single fabric filter collector may be less onerous than a FGD or a SCR catalytic converter, many of the steps are still the same.

REVIEW OF KEY UNCERTAINTIES

In summary, several key uncertainties behind the proposed mandates in 2014 and 2015 should be considered:

Equipment Installation Timeline

EPA's assumed timeline for equipment installation – based on experience gathered from 2008 through 2010 – is unrealistic. The FGD and SCR installations completed prior to 2010 were mandated five years prior to the compliance date. As EPA has noted in CSAPR rulemaking documents, some large system owners initiated work prior to 2005, but in response to incentives to acquire SO_2 allowances. Owners had a financial incentive to deploy technology early – and not a disincentive of putting capital at risk, which is the present case.

Capability of Sorbent Injection for Hg Control

The use of activated carbon sorbent to remove mercury has been demonstrated to meet the proposed MACT mercury limit for several categories of generating units. However, an equal number of generating units could be at risk to meet the proposed MACT limit using activated carbon sorbents, unless a fabric filter is retrofit.

Capability of Sodium-Based Sorbents to Remove Hydrogen Chloride to the MACT Limit

Sodium-derived sorbents have been used to remove acid gases such as hydrogen chloride, but there is limited experience in achieving the low levels mandated by the MACT. At this time there are only two operating units with data suggesting this option can potentially meet the proposed Utility MACT rule.

Capability to Broadly Retrofit Fabric Filters

EPA's analysis of complying with the MACT is predicated on the ability to successfully retrofit 166 GW of generating capacity with fabric filter controls by January of 2015. As noted in an analysis that I co-authored and submitted in July of 2011 as comments to MACT (a copy of which is attached to this testimony), it is unlikely this amount of fabric filter control technology can be retrofit by January of 2015. Successfully retrofitting fabric filters to this capacity alone would be a challenge, much less conducting this work contemporaneous with FGD scrubber retrofit for the CSAPR.

EXHIBIT 1

Perspective Drawing of Wet Flue Gas Desulfurization (FGD) or Scrubber Process
(Source: Babcock Power, Inc.)

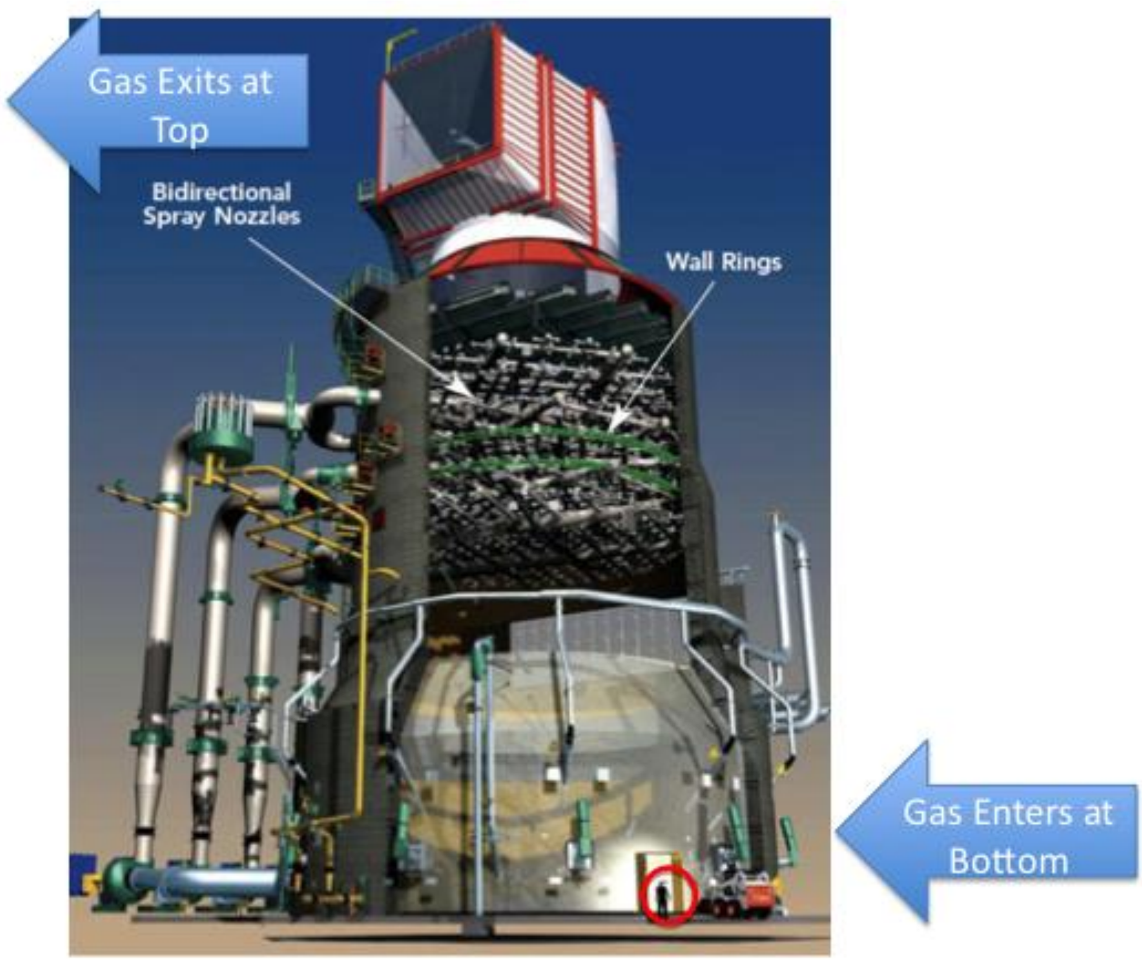

EXHIBIT 2

Selective Catalytic Reduction (SCR) Catalytic Reactor
(Source: Babcock & Wilcox)

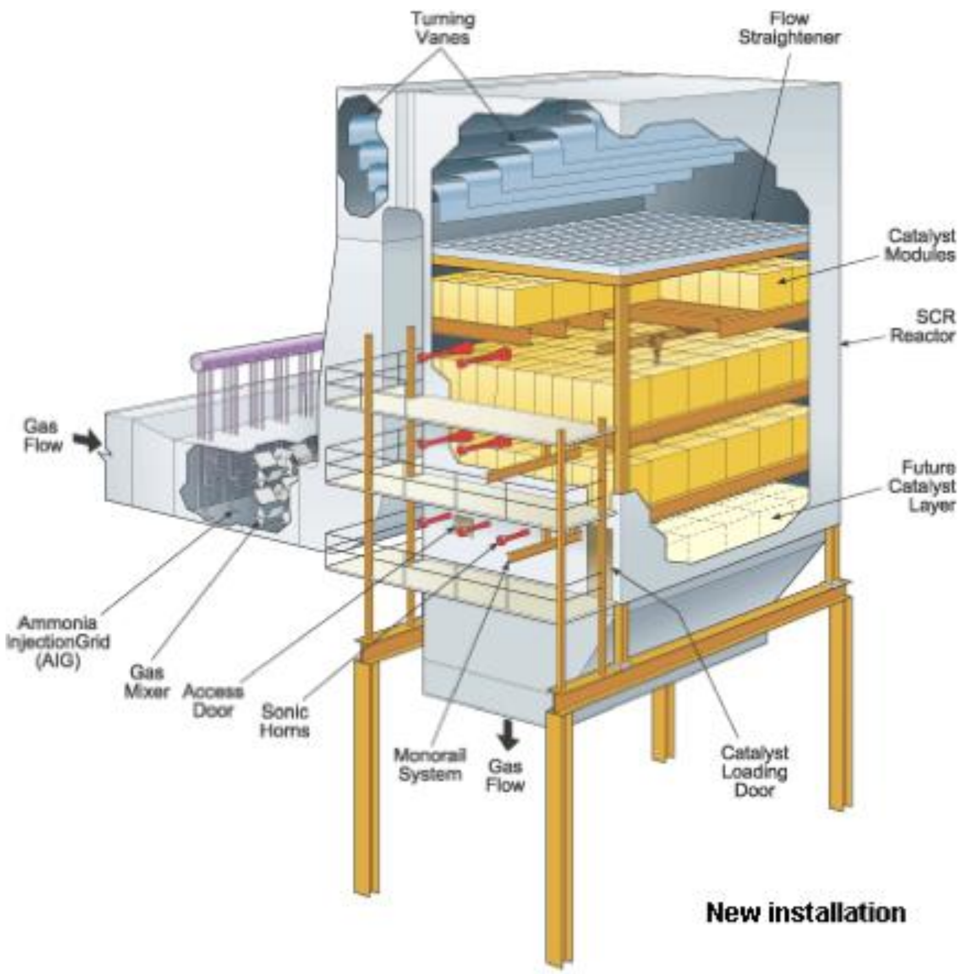

EXHIBIT 3

Fabric Filter Particulate Collector
(Source: Babcock & Wilcox)

EXHIBIT 4

Large Generating Plant Layout Depicting Location of Environmental Control Equipment
(Source: Satellite Image)