Particulate and Opacity Control - Program 76

Program Overview

Program Description

Coal- and oil-fired power plants face increasing challenges in meeting emission limits for particulate matter as a result of the March 16, 2011, proposal by the U. S. Environmental Protection Agency (EPA) of Maximum Achievable Control Technology (MACT) standards for hazardous air pollutant (HAPS) emissions from electric generating units (EGUs). These limits, when finalized, will challenge power plants’ ability to meet the requirements for both filterable and condensable particulate matter (FPM and CPM); they are proposed to be very stringent, because they are intended to serve as surrogates for nonmercury hazardous trace metals — FPM for the solid species and CPM for any condensable hazardous trace metals, such as selenium. Further, the proposed rules encourage the use of activated carbon injection for mercury and dry alkaline injection (calcium- or sodium-based) for acid gases and SO₃ (to avoid a blue plume or sulfuric acid fallout), increasing loading into the particulate controls. For electrostatic precipitators (ESPs), the added solids loading, coupled with reduced SO₃ concentrations, make it difficult for them to capture particulates; in baghouses, these conditions may lead to corrosion, blinding, and premature bag failures. The increasing drive for fuel flexibility (including increased deployment of higher-sulfur coal following installations of FGD systems) and biomass co-firing further challenge particulate controls, especially for aging or marginal units.

The Electric Power Research Institute’s (EPRI’s) Particulate and Opacity Control program (Program 76) seeks or develops and evaluates emerging technologies that economically satisfy increasingly stringent particulate emission and opacity limits under a variety of operating conditions, including changes in ash properties and loadings, fuel sulfur content, and SO₃ sorbent use.

Research Value

EPRI searches for, develops, and demonstrates particulate (FPM and CPM) control technologies that can achieve members’ performance goals for complying with the final MACT standards. High priority is given to cost considerations; for existing plants with ESPs, to reduce their risks of early retirement; for new or existing plants with baghouses, to minimize operations and maintenance (O&M) costs. Members of this program can use the results of this R&D to achieve:

- Savings of as much as $50–$150/kW by avoiding ESP replacement with a baghouse or supplemented by a TOXECON™ or wet ESP retrofit to meet the eventual MACT standards;
- Savings in avoided replacement power costs due to opacity-driven derates;
- Extended bag life and lower pressure drop through better fabrics for baghouses;
- Continued ash sales and reduced reagent costs if operational modifications, together with optimized alkali injection systems, can reduce the quantity of alkali injected for SO₃ control;
- Improved effectiveness of activated carbon mercury control through alternatives to SO₃ flue gas conditioning for high particulate matter (PM) capture in ESPs; and
- Improved baghouse performance through better O&M practices.

Approach

Projects conceive of, or find and demonstrate, least-cost upgrades for meeting the increasing particulate (FPM and CPM) control challenges (lower emission limits and loss of startup/shutdown/malfunction exemptions) imposed by the proposed MACT standards, Title V permits, and other regulatory actions. This work also addresses upgrades needed to counter the potential impacts of changed particulate properties on ESP or baghouse performance due to fuel switching, biomass cofiring, or sorbent injection. The R&D includes:
• ESP upgrades for compliance with increasingly stringent emission limits, undersized units, or units with
difficult-to-capture fly ash. Upgrades may include development and demonstration of advanced power
supplies, flow modifications, and novel ESP technologies that counter the effects of high-resistivity ash,
sodium depletion in hot-side ESPs, rapping losses, and changed ash properties. These property changes
are expected to be driven by carbon injection for mercury control and alkali injection for SO$_3$, acid gas,
and, possibly, selenium control.

• Research to optimize baghouse performance for all fly ash develops methods to extend bag life, reduce
pressure drop, avoid “cleaning puffs,” and detect leaks, all irrespective of fly ash properties. Recognizing
the recent large increase in number of baghouse installations, this project finds and shares best O&M
practices to maximize bag life and minimize pressure drop.

• Robust, least-cost acid emission reduction demonstrations of fuel, combustion, and boiler operation
modifications that could reduce SO$_3$ formation in the boiler; updates on industry experience with SO$_3$
controls; and a Tech Watch for novel mitigation measures.

Accomplishments

EPRI provides power companies with solutions to solid and aerosol particulate emissions that are not available
from equipment suppliers due to small returns on investment or high risk. EPRI tests new commercial offerings
to demonstrate their performance and to assist their developers in improving the products. Recent examples
include:

• Publication of a survey of baghouses installed within the last 10 years, identifying practices adopted to
minimize O&M costs while meeting stringent emission limits. This was an initial 2010 report, with plans for
a 2011 deeper-dive report.

• Enhancements to EPRI's ESP performance software, ESPM, to improve prediction accuracy when
treating flue gas with alkali sorbents or increased carbon content. This program is widely used to
troubleshoot performance issues, or to predict the impact on particulate emissions/opacity of changing
fuels or implementing upgrades.

• Preliminary demonstration of extended time between off-line cleaning on hot-side ESP using EPRIswitch.

• Demonstrated ability by end of 2011 of: a) the Rapid Onset Pulse Energization (ROPE) power supply to
provide high-efficiency collection of high-resistivity fly ash without the need for SO$_3$ flue gas conditioning,
and b) EPRIswitch with polarity reversal to eliminate the need for sodium conditioning for hot-side ESPs.
Success in these efforts would not only reduce operation and maintenance (O&M) costs, but also avoid
the negative effects of SO$_3$ on mercury capture by activated carbon and of the added sodium on the
salability of the fly ash collected in hot-side ESPs.

• Identification of a flow control design that nearly eliminated ESP hopper re-entrainment of fly ash with
elevated carbon content in one ESP.

• Reduction of ESP particulate emissions by 40–70% in a novel polishing device, EPRI's PMscreen.

• Lower-pressure-drop baghouse fabrics that retain high particulate collection.

Current Year Activities

The program R&D for 2012 will seek to complete any work still needed to demonstrate the effectiveness of
advanced power supplies (ROPE and EPRIswitch) in achieving collection of high-resistivity ash by cold- or hot-
side ESPs, respectively, without alkali addition. It also will continue to develop PMscreen, a low-cost particulate
polishing system. Other activities will seek and inform members of new fabrics and best-practice baghouse
operations, develop guidelines for upgrading ESPs to meet their new challenges, and enhance the reliability and
reduce the cost of SO$_3$ control. Specific efforts will include:

• Demonstration at 1 MWe scale of PMscreen as a low-cost polishing device (e.g., to counter particulate
increases due to sorbent injection air pollution controls or to meet more stringent emission limits);

• Search for and testing of new fabrics to simultaneously reduce pressure drop and emissions during
cleaning while resisting degradation due to sorbent injection. Possible tests of new sorbent-impregnated
filter media for multipollutant capture;
- Demonstration of a combination of low-cost upgrades to be identified and qualified by an engineering study planned to be completed in 2011 that, together, can enable existing cold-side ESPs to support the MACT limits for mercury, other trace metals, and acid gases at existing plants (i.e., can handle the increased particulate loading and more difficult solids while meeting reduced emission limits);
- Demonstration of the ability of computational fluid dynamics (CFD)-designed hopper baffles to reduce ESP performance degradation with high unburned carbon containing ash or injected activated carbon (second site to confirm wide applicability);
- ESPM upgrades that can better predict particulate emissions/opacity with high-frequency power supplies; and
- Determination of the ability to achieve significant SO$_3$ reductions through boiler operational changes or deeper coal cleaning/upgrading via application in full-scale tests.

**Estimated 2012 Program Funding**

$1.8M

**Program Manager**

Anthony Facchiano, 650-855-2494, afacchia@epri.com

## Summary of Projects

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<thead>
<tr>
<th>Project Number</th>
<th>Project Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>P76.001</td>
<td>ESP Upgrades for New Emission Limits, Small Units and/or Difficult Fly Ash</td>
<td>This project will develop low-cost upgrades to ESPs that meet the new challenges of complying with increasingly stringent emission limits, collecting difficult ash, and avoiding emission increases despite higher inlet loadings. Updates to ESPM, EPRI's performance prediction tool, will support these technology developments.</td>
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<tr>
<td>P76.002</td>
<td>Optimized Baghouse Performance for All Fly Ash</td>
<td>Through O&amp;M guidelines, identification and testing of new fabrics capable of meeting anticipated MACT emission limits, and supporting basic tests of ash/bag material properties, this project will document best practices and develop bag materials that consistently produce lower emissions, longer bag lives, and lower O&amp;M costs.</td>
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<tr>
<td>P76.003</td>
<td>Robust, Least-Cost Acid Emission Reduction</td>
<td>This project identifies and demonstrates lower-cost and more-reliable SO$_3$/sulfuric acid mitigation strategies, mitigating the impact of a MACT limit on condensables, reducing back-end corrosion, and eliminating blue plumes.</td>
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</table>
P76.001 ESP Upgrades for New Emission Limits, Small Units and/or Difficult Fly Ash (069166)

Key Research Question

On March 16, 2011, the U.S. EPA proposed MACT standards for electric generating units (EGUs) that will require coal- and oil-fired power plants to meet very stringent limits for filterable and condensable particulate matter (FPM and CPM), and to do so with increased PM loading and difficult-to-capture materials. The PM limits are proposed as surrogates for nonmercury HAPS metals (FPM) and volatiles such as selenium (CPM), while the capture difficulty comes from the injection of activated carbon for mercury control and, potentially, alkaline sorbents for acid gas, SO₃, and selenium reduction.

In addition, many ESPs are too small to meet current emission/opacity limits; are being used to collect a higher-resistivity dust than the design fly ash (i.e., following a switch to Powder River Basin [PRB] coal or after implementation of calcium-based sorbents for SOx reduction); or are hot-side ESPs that continue to experience performance issues. These situations — along with the desire to eliminate SO₃ flue gas conditioning in plants that use activated carbon injection for mercury control (SO₃ interferes with carbon effectiveness in capturing mercury) — will require the upgrade of many ESPs. The industry and public would benefit from lower-cost approaches than adding or replacing the ESP with a baghouse. Several advanced power supplies have the potential to meet this need, as do some alternate flue-gas-conditioning chemicals, but all remain to be proven for a number of applications. Other technologies, such as low-cost polishing devices or elevated ash particle charging current made possible by the use of cooled collecting surfaces, may be competitive and provide better performance than SO₃ conditioning. They merit further development and demonstration.

Power companies constantly face questions about the impact of fuel changes on ESP performance and the benefits of proposed upgrades. To answer these questions on ESP performance, environmental control engineers need a comprehensive, reliable, and accurate computer model. EPRI's ESPM model is such a tool and is effective, but needs updating as more is learned about ESP performance with advanced power supplies, or improvements, or difficult-to-collect ash.

Early adopters of wet ESPs placed behind the flue gas desulfurization (FGD) system have experienced corrosion and could benefit from guidance on material selection and water chemistry management to avoid these issues.

Approach

The key activities proposed for 2012 are:

- **Combinations of ESP upgrades.** In 2011, EPRI is assembling a report on ESP performance improvements that have been or could be realized by combining retrofit of advanced power supplies with a set of other ESP upgrades, such as wide plate spacing, improved flow distribution, and modern discharge electrode designs. The objective is to enable existing ESPs to meet the PM limits inherent in the proposed MACT rule and avoid the costly replacement with a baghouse. In 2012, EPRI will seek host sites to demonstrate two to three of the retrofit combinations identified in the 2011 report.

- **ROPE and EPRIswitch.** Based on results from field trials in 2011, EPRI will seek one to three additional demonstrations of EPRIswitch and Southern Company's ROPE technology, alone or together, at plants burning PRB or injecting calcium sorbents for SOx control. One of these field trials may occur at a hot-side ESP suffering performance degradation due to sodium depletion.

- **Re-entrainment management.** For ESPs experiencing carbon re-entrainment, EPRI will seek an additional site to demonstrate the use of computational fluid dynamics (CFD) models to design flow devices that minimize hopper re-entrainment (even of light carbon particles). The effort will include design, fabrication, and installation of the flow devices, followed by EPRI performance testing.
PMscreen. EPRI will continue to develop its polishing device, PMscreen, focusing on low-cost ways to improve its capture performance to >70% of the remaining PM at the ESP outlet without excessive pressure drop. Approaches being considered include the use of metal and polymer felt screen materials, pre-charging the ash, or locating the device downstream of the FGD (instead of a wet ESP).

Other activities that EPRI may undertake, subject to funding and member priorities, include:

- **ESPM upgrade for advanced power supplies.** With the widespread introduction of high-frequency power supplies, it is important to verify that the electrical performance algorithms in ESPM are being extrapolated correctly to the higher charging levels and collecting processes. Accordingly, EPRI will revisit these first-principles algorithms, update them if needed, and test the results against field data (e.g., at the host sites demonstrating the benefits of a prudently selected combination of upgrades). EPRI expects to identify algorithm changes and incorporate them into ESPM in 2012. Validation, testing, and release of the next version of ESPM would occur in 2013.

- **Cooled plates.** Assuming a successful feasibility study in 2010-11 under the Technology Innovation program, EPRI will begin the process of designing and testing a novel configuration that physically integrates “cool pipes” for charging (high-resistivity) particles with the collection plates, leaving the rest of the plate to operate at a lower current and, therefore, avoid back corona. At a minimum, this approach could be a fallback option in the event that advanced power supplies do not reach their potential.

- **Wet ESPs.** EPRI also may seek additional sites to test the performance and operability of the new generation of wet ESPs located post-flue gas desulfurization (FGD) systems in new plants. This investigation will include work to determine the cause of discharge electrode and other component failures, possibly caused by early corrosion onset in some of the newly installed post-FGD wet ESPs. EPRI will build off its substantial experience with FGD materials of construction and its earlier development of water management guidelines for wet ESPs. Pending experience gained in these applications, EPRI may revisit its earlier concept of converting the last field of a conventional ESP to wet operation, taking advantage of the lessons learned during that earlier work. The most important lessons dealt with management of water flow inside the ESP and, as noted, its chemistry. This revisit will include an assessment of the potential value of using membrane plates instead of metallic ones when converting the last field to wet operation.

All the above-mentioned field tests will require supplemental funding for equipment upgrades and detailed sampling. Program 76 will provide the labor to find and organize the tests as well as provide overall project management.

**Impact**

By having EPRI develop and demonstrate low-cost ESP upgrades or other solutions to increasingly stringent particulate emission limits and issues caused by difficult PM, power companies can:

- Save as much as $15–$25/kW if advanced power supplies, alone or in combination with other low- to moderate-cost upgrades avoid the need for an additional ESP field, or as much as $40–$80/kW if they avoid a polishing baghouse. This could be the difference between running or retiring shoulder units once the MACT compliance date arrives

- Enable the use of sorbent injection for SO₂ control in small or low-capacity-factor plants by avoiding the additional cost of a baghouse.

**How to Apply Results**

Power plant owners and operators will be able to procure and tune EPRIswitch, integrated in the future with ROPE, if needed, to meet their particulate/opacity emission limits at much lower cost than other options. They also will receive information about advanced power supplies and a suite of other low- to moderate-cost upgrades that can make them better able to develop least-cost compliance options for the MACT rule. Similarly, the reports on hopper baffles for ESPs collecting high-carbon fly ash will provide guidance on the design and expected effectiveness of this low-cost upgrade, and those on PMscreen will give engineers the information they need.
need to decide on the adequacy of this polishing device for their situation. Predicting the benefits of any of these approaches can be done by running ESPM, a model that has been modified over the years to increase its ease of use, robustness, and applicability.

### 2012 Products

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<tr>
<th>Product Title &amp; Description</th>
<th>Planned Completion Date</th>
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<tr>
<td><strong>Low-Cost ESP Retrofit Devices for New Challenges: MACT limits, Increased PM Loading, High-Carbon Ash, or Biofuels:</strong> This project will provide performance results from sites that have applied one or more of the upgrade technologies investigated by EPRI in 2011 (report due 3Q11). This report is likely to center on combining advanced power supplies (typically high-frequency switch mode) with other upgrade technologies aimed at improving basic performance; addressing PM property changes due to sorbent injection for mercury, acid gases, and condensables (especially SO₃); and reducing re-entrainment (especially carbon).</td>
<td>12/31/12</td>
<td>Technical Update</td>
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<tr>
<td><strong>EPRIswitch and Other Advanced Power Supplies for Difficult ESP Applications -- Update:</strong> A separate report on these two novel, pre-commercial advanced power supplies. Update of a 2011 report, with majority of report being new field test results. It will include the benefits of the joint operation of ROPE and EPRIswitch to create a fuel-insensitive ESP, if a host site can be found.</td>
<td>12/31/12</td>
<td>Technical Report</td>
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<tr>
<td><strong>PMscreen Performance Update:</strong> Test results from pilot and field demonstrations of this PM polishing device — PM emissions, pressure drop, and system durability. This report will include preliminary engineering/economic study of potential commercial applications.</td>
<td>12/31/12</td>
<td>Technical Update</td>
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### Future Year Products

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<tr>
<td><strong>ESPM 6.0:</strong> Update to ESPM 5.0 (a late 2010 product) to include robust treatment of high-frequency power supplies, alone or in combination with other upgrades, and updates as needed for biomass and various sorbents.</td>
<td>09/30/13</td>
<td>Software</td>
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<tr>
<td><strong>Low-Cost ESP Retrofit Devices for New Challenges: MACT limits, Increased PM Loading, High-Carbon Ash, or Biofuels:</strong> Final report in series, with field test results on a range of technologies and combinations. It will include performance of technologies introduced in 2012-13. More results on units with hopper re-entrainment (especially of activated or unburned carbon) are expected than were available in 2012. Also will, include data on novel technologies, such as cooled-plate ESP for high-resistivity fly ash.</td>
<td>12/31/13</td>
<td>Technical Report</td>
</tr>
<tr>
<td><strong>EPRIsswitch and Other Advanced Power Supplies for Difficult ESP Applications:</strong> Update of 2012 report on field test results at additional sites, especially those with high-resistivity ash (PRB or sorbent injection for SOₓ mitigation) and hot-side ESPs with sodium depletion issues.</td>
<td>12/31/14</td>
<td>Technical Update</td>
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### P76.002 Optimized Baghouse Performance for All Fly Ash (069167)

**Key Research Question**

Power companies increasingly are turning to baghouses (aka fabric filters) to realize very-low-total particulate matter (PM) emissions independent of fuel properties, and for compliance with the MACT standards (when finalized). For MACT, baghouses offer substantial reductions of trace metals through the capture of fine
particulate; high capture rates of mercury on unburned or activated carbon; and the potential to also capture selenium, sulfuric acid, other acid gases (especially hydrochloric acid \([\text{HCl}]\) and hydrofluoric acid \([\text{HF}]\)), and any organic gases present in the flue gas via sorbent injection. However, baghouses can experience high-pressure drop after only a few months or years of operation, and this factor imposes an energy penalty on the power plant, a derate, or a cost penalty for frequent bag replacements. Further, it is unclear if current bag materials and baghouse operation practices can routinely meet the ultra-low emission limits being considered by regulatory agencies — e.g., 0.005 to 0.015 lb/MBtu filterable PM in order to meet a MACT total proposed PM (filterable plus condensable) limit of 0.003 lb/MBtu. Additionally, bag materials can fail within 1–3 years of installation, which adds an undesirable cost to the system and runs the risk and expense of forced outages. Research is needed on new bag materials that are stronger, resistant to flue gas species (especially sulfuric acid, chlorine, and bromine), porous enough to avoid undue pressure buildup, and still highly efficient during both normal capture operation and cleaning cycles.

Companies operating or planning to install baghouses also can benefit by learning how other users maximize the performance and minimize the costs of their baghouse operations. A collaborative search for and synthesis of these lessons learned is the most cost-effective way to obtain this knowledge.

**Approach**

To make baghouses that are more robust, have lower pressure drop, and offer consistently high-collection efficiency available to power companies, EPRI will pursue three parallel paths: 1) preparation of operation and maintenance (O&M) guidelines for baghouses, based on a synthesis of observations from the 2010–11 surveys and visits to sites with current generation baghouses; 2) continued Tech Watch for new developments by bag material suppliers of fabrics that address collection efficiency, pressure drop, and durability; and 3)asic R&D to determine the tenacity, pressure drop, and chemical impacts of dust cakes that build up on bags. EPRI also will try to conceive, as well as search for, novel ideas that it can suggest to the material suppliers, and then test the samples that suppliers produce.

Based on the surveys and site visits conducted in 2009–11, EPRI will document the lessons learned by the individual baghouse operators and analyze these lessons for trends or common experiences. These findings will form the basis of the guidelines, which will highlight fabric selection for different fuels and back-end temperatures, and startup, shutdown and bag cleaning procedures to minimize excessive pressure drop and premature bag failures (acid attack and blinding). Other topics include:

- Instruments to detect leaks;
- Options to control baghouse cleaning parameters and pressure drop;
- Decision criteria on when to replace bags;
- Special considerations when used with sorbents (activated carbon, alkali); and
- Future opportunities applying novel concepts.

In parallel, EPRI will conduct slipstream pilot or full-scale tests of fabrics and procedures that could enable baghouses to achieve continuous ultra-low PM emissions during both steady operation and cleaning periods, while maintaining acceptable pressure drop and cleaning frequency over a long time period. The slipstream tests will be conducted at scales ranging from EPRI's 40 acfm Pollution Control Tester [PoCT] to a power company-owned 2 MWe system, depending on test needs and equipment availability. Given the anticipated stringency of the final PM MACT limits, EPRI will seek newer bag materials, such as dual-density fabrics, that have lower permeability than today's 7 denier fabrics, but also do not allow penetration of fine ash into the fabric pores. To accelerate the development of the new materials and O&M procedures needed to comply with the final MACT standards, EPRI will conduct research on the mechanisms that control ash behavior on a bag. Chief among these are dust cake tenacity on the bags and the impacts of different sorbents and cleaning procedures on pressure drop. These issues seem to be most prevalent at sites with medium to high \(\text{SO}_3\) concentrations in the flue gas being treated by the baghouse.
Impact

Success in addressing the issues identified for baghouses will lead to:

- Ability to meet MACT rules for filterable PM even if the final emission limits are extremely stringent (e.g., if < 0.01 lb/MBtu continuously);
- Increased intervals between bag replacement for challenged baghouses from the current 2–3 years to potentially 4–5 years, at a typical amortized savings of $0.5M/yr for a 500-MW plant (plus reduced downtime);
- Maintaining pressure drop across the baghouse below 5–6 in. H₂O, vs. allowing it to increase, e.g., to 10 in. H₂O, saving as much as $200,000/year or more for a 500-MW plant, or avoiding a derate for a fan-limited unit;
- More compact designs of baghouses, with higher air-to-cloth ratios and online cleaning, saving 10–20% in capital costs;
- Improved baghouse design and operating practices for power plants using multiple sorbents for HAPs control;
- Potential savings that could range from modest to large, depending on the errors avoided by the next wave of installations or the changes in O&M practices adopted by current and future users as a result of learning best practices from the survey; and
- Potential avoidance of emission limit violations by understanding the variability in baghouse emissions.

How to Apply Results

Plant engineers can use the O&M guidelines to improve the performance of their existing baghouses, reduce O&M costs, and avoid potential derates due to opacity excursions. Engineering/procurement staff can use the results to specify the most cost-effective baghouses for their needs, accounting for capital vs. O&M cost tradeoffs. Corporate environmental engineers can gain an understanding of future challenges and possibilities by following the progress of the R&D in novel fabrics. They then can use this understanding to recommend optimal particulate control strategies.

2012 Products

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<tr>
<td><strong>Operations and Maintenance Guidelines for Optimal Baghouse Performance</strong>: This project will identify best practices as determined by the 2009–11 surveys and site visits, including experience with different fabric/fuel/boiler combinations, startup/shutdown practices, and bag-cleaning practices.</td>
<td>12/31/12</td>
<td>Technical Report</td>
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Future Year Products

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<tr>
<td><strong>Advances in Baghouse Materials</strong>: Status report on bag material developments during 2012–2013.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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P76.003 Robust, Least-Cost Acid Emission Reduction (101447)

Key Research Question

In addition to ongoing concerns about visible blue plumes caused by sulfuric acid mist and new limits on SO₃ and sulfuric acid emissions, power plants soon may face MACT limits on condensables as a surrogate for selenium. Operators also are worried about boiler impacts due to high SO₃ and sulfuric acid concentrations in the colder section of the air preheater and downstream components. Plants that need to reduce SO₃ emissions currently can only capture SO₃ that has been formed in the boiler by injecting alkali sorbents or adding a wet ESP. As both approaches are expensive, and sorbent injection can have negative side impacts, power plants seek lower-cost approaches such as mitigating the initial formation or enhancing the depletion of SO₃ through modified boiler operations and coal cleaning.

At plants using sorbent injection, operators need guidance on sorbent specification, handling, transport, and injection to maximize sorbent utilization and greatly reduce current maintenance.

Approach

EPRI will conduct a multiprogram effort to reduce SO₃ emissions via combustion controls that minimize formation in the boiler, low SO₂ oxidation catalysts for postcombustion NOx control via selective catalytic reduction (SCR), and optimized alkali injection (for SO₃ capture and/or acid gas control). This work will bring together expertise and resources from Program 71 (Combustion Performance and NOx Control), Program 73 (Postcombustion NOx Control), and Program 75 (Integrated Environmental Controls) to:

- Reduce excess air, a prime contributor to SO₃ formation, without sacrificing CO, SCR outlet NOx, unburned carbon, boiler efficiency, or corrosion. Also, evaluate the ability to reduce catalytic oxidation of SO₂ to SO₃ significantly via enhanced coal cleaning to remove large amounts of iron and sootblowing schedules designed to minimize SO₂ oxidation by deposits on convective pass tubes (Program 71);
- Evaluate suppliers’ offerings of low-SO₂ oxidation catalysts for their ability to make a significant difference while retaining their mercury oxidation and NOx reduction capabilities (Program 73);
- Collect data on SO₃ reductions/emissions at sites testing alkali injection for acid gas capture to meet proposed MACT limits. Also, follow the modification of EPRI’s on-site sorbent activation process (SAP), initially focusing on activated carbon injection for mercury control, to produce a hydrate on demand (would be lower cost than purchased hydrate and avoids pluggage issues because it is created and transported immediately without aging) (Program 75); and
- Complete the development or assessment and demonstration of robust, low-maintenance alkali sorbent storage, handling, transport, and injection systems, especially for hydrated lime, as well as the design of injection systems that minimize sorbent usage for any given application. Also, continue to track supplier developments and new offerings, evaluating (to the extent the supplier and host plants agree) those that seem promising. (this Program/Project).

EPRI will work with members to select and test the most promising SO₃ minimization strategies at host power plants.

Impact

By finding and demonstrating cost-effective methods to reduce SO₃ concentrations experienced in the post-air preheater region of a coal-fired boiler, this RD&D effort will:

- Minimize back-end corrosion;
- Reduce the potential for derates to avoid opacity violations, which could cost hundreds of thousands of dollars per event in replacement power;
- Lessen or eliminate the concern over the proposed MACT limit on condensables (as a surrogate for selenium);
- Save as much as $1–$2 million/year for a 500-MW plant if it can avoid alkali injection, or a fraction thereof if it can only reduce the amount injected; and
- Reduce nearby touchdowns of sulfuric acid plumes.
How to Apply Results

Engineers can use the results of the proposed studies and field tests to identify the most favorable SO$_3$ reduction strategies for their plants and coals. Working through EPRI, they can access the computer models of SO$_3$ formation/depletion that were developed by Lehigh University and Southern Research Institute and run the models for their power plants and fuels to gain an initial assessment of potential SO$_3$ mitigation strategies. Members also can join the Sulfur Oxides Control Interest Group (SOXIG), a supplemental project that provides a forum for technology exchanges among practitioners.

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<tr>
<td>New Approaches to SO3 Mitigation in Coal-Fired Boilers: Report on pilot and field tests of potential SO$_3$ mitigation and capture tests. It includes performance and O&amp;M experience at commercial installations of alkali injection for SO$_3$ reduction.</td>
<td>12/31/12</td>
<td>Technical Update</td>
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<td>New Approaches to SO3 Mitigation in Coal-Fired Boilers: Update of 2012 report with additional longer-term data from sites included in 2012 report and new results from sites/approaches not studied previously.</td>
<td>12/31/13</td>
<td>Technical Update</td>
</tr>
<tr>
<td>Guidelines on SO3 Mitigation in Coal-Fired Boilers: Guidelines for reducing SO$_3$ flue gas concentrations along the flue gas path and at the stack, including strategies to reduce SO$_3$ formation and best practices to control it once formed.</td>
<td>12/31/14</td>
<td>Technical Report</td>
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