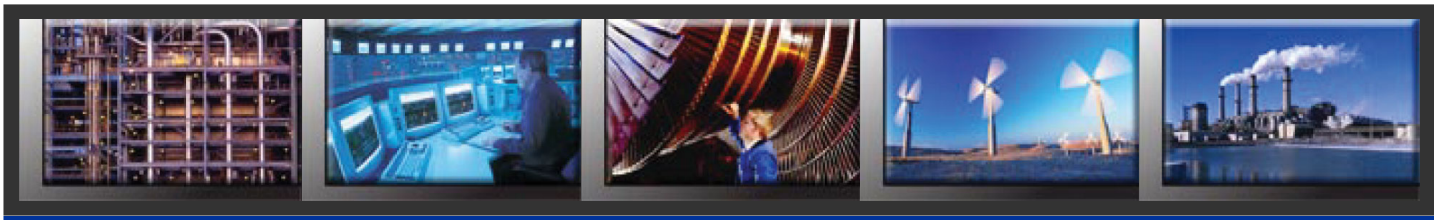
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Generation Sector Update



A Monthly Report from EPRI's Generation Sector **January-March 2008**

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DEAR EPRI GENERATION MEMBERS

As you probably know by now, on March 1 we announced the beginning of a process to integrate EPRI's Generation sector activities more closely with our related work in the Environment sector. This action will deliver greater research value to you, provide industry leadership and respond more effectively to the environmental drivers that are so critical today – particularly climate change and the implications it has for new and old generation units of all types. In addition, this action will create opportunities for high-potential technical leaders and program advisors to take on broader cross-issue roles that will inevitably lead to new and innovative solutions for fossil-based generation and environmental protection. There are quite a few details yet to sort out, and I and my colleagues at EPRI look forward to discussing them with you at future advisory meetings during the rest of 2008.

Meanwhile, EPRI's technical staff have continued to deliver excellent results such as those highlighted in this issue of our newsletter. In our Advanced Generation area, we continue to review several new promising post-combustion CO_2 capture technologies, and are making plans to propose to the EPRI Board and industry in April several demonstration projects to move these concepts from analysis to action. We are also moving closer to our goal of a risk-informed approach to plant maintenance through new work under our Operations and Maintenance Excellence (OMX) Initiative, and held a second successful and widely-attended Plant Managers' Forum. Finally, the recent Supreme Court remand of the Clean Air Mercury Rule has highlighted the need for advanced mercury control technologies, and our work with activated charcoal in our Environmental Controls area shows promise for developing an efficient, cost-effective approach to mercury control under a wide range of plant conditions.

These are but a few of the examples of the valuable work going on within the Generation sector, and with your wise advise and counsel, we can only do more in the coming weeks and months ahead. Thanks, as always, for your support of EPRI and its research programs.

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CoalFleet for Tomorrow-Future Coal Generation Options (Program 66)

EPRI Team Begins CO_2 Capture Retrofit Study.

In January, EPRI staff and members of the CoalFleet IGCC Experts group began work with Duke Energy on a feasibility study (pre-FEED level) of partial and full CO_2 capture retrofit options for the Edwardsport IGCC plant. The plant received its air permit on Jan. 25, which was the final regulatory hurdle prior to plant construction projected to begin in March. The pre-FEED analysis is a part of a study of the capture of CO_2 from unshifted syngas using process data from the Edwardsport IGCC plant design. In addition to the 15%-18% capture case, EPRI will study configurations for 50-60% and 80-90% capture from the plant. Scheduled for completion in May-June 2008, this project takes advantage of EPRI's tailored collaboration program and will result in publication of non-confidential results. For more information, contact either Ron Schoff (rschoff@epri.com, 704-595-2054) or Frank Carchedi (frank.carchedi@duke-energy.com, 317-838-1822).

EPRI's Steele on the Road Again.

EPRI Senior Project Manager Dr. Robert Steele spent much of January on the road. His journeys began Jan. 8 and 9, when he visited Siemens Power Systems in Orlando, Florida to discuss progress with its DOE projects. On Jan. 14 and 15, Steele was in Ohio to talk with Battelle and First Energy about the next step towards installing a CO_2 compressor at the Burger coal plant. This work is part of the carbon capture and storage (CCS) activities of the DOE Midwest Partnership. Steele was back in Charlotte Jan. 24, where he organized a meeting of EPRI staff and Air Products representatives to discuss the latest developments of the Ion Transport Membrane (ITM) technology. Steele was on the west coast Jan. 29 for a visit with the technical staff at Stanford University, to kickoff the next phase of its laser project to measure real-time gasifier gas temperature. Prof. Ron Hanson of the High Temperature Gasdynamics Laboratory in Mechanical Engineering at Stanford has received a follow-on EPRI Technology Innovation award for 2008. The project is to continue the development of a laser-based sensor for monitoring fuel heating value and combustion temperature in coal gasifiers. The objective of the work is to demonstrate the prototype sensor in a coal gasification environment. The host site will be announced in the next few months.

Steele wrapped up his hectic schedule Jan. 30 at the Idaho National Laboratory in Idaho Falls, where he and Dr. Humberto Garcia, technical lead, discussed a potential joint project with EPRI on gasification refractory life-cycle predictions. For more information about these projects, contact Steele (rsteele@epri.com, 704-595-2025).

CO_2 Capture & Storage (Program 165)

EPRI Studies New Post-Combustion CO_2 Capture Technologies.

Under the Generation “Showcase Technology Innovation (TI) project,” EPRI staff reviewed a number of recently announced post-combustion CO_2 capture technologies, including The Ohio State University's Carbonation/Calcination Reaction (CCR) technology, a process which reacts carbon dioxide with calcium oxide at high temperatures; the University of Wyoming's proprietary carbonaceous-based adsorbent; Carbon Trap; zeolite imidazolate frameworks (ZIFs), a new high-capacity sorbent; HTC Purenergy (an advanced amine); ADA-ES Sorbent, and Aker Clean Carbon. Summaries and key attributes of each technology are stored in a database. A few of these emerging processes offer the promise of 30+% reduction in energy consumption relative to the baseline MEA, but none approach EPRI's goal of ≤ 10% parasitic load. Power companies are encouraged to contact EPRI for questions about CO_2 capture processes or recommendations for new processes to evaluate. For more information, contact Brice Freeman (bfreeman@epri.com, 650-855-1050) or Abhoyjit Bhown (abhown@epri.com, 650-855-2383).

Drilling Begins for First of Two CO_2 Storage Wells; 1.7 MWe Chilled Ammonia CO_2 Capture Pilot Unveiled At Press Conference.

The well is for injection and will reach a depth of approximately 8,500 feet when completed in March. During drilling, rock cores will be obtained from two caprock strata and the storage strata. Drilling on the observation well will commence immediately following completion of the injection well. The chilled ammonia demonstration dedication planned for Feb. 27 was cancelled due to weather, but the We Energies, Alstom, and EPRI team still held the press briefing. Presentations were made by Gale Klappa, Chairman, President and CEO of Wisconsin Energy Corporation; Jean-Michel Aubertin, SVP Energy & Environment Systems Group, Alstom; and Hank Courtright, SVP Member Services, EPRI. More than 400 media "hits" resulted from the event. Alstom currently is shaking down the system and expects to start testing during the second half of March. For more information on both projects, contact Richard Rhudy (rrhudy@epri.com, 650-855-2421).

MAJOR COMPONENT RELIABILITY

Steam Turbines, Generators, and Balance-of-Plant (Program 65)

EPRI Guidelines Reduce Time and Cost of T-G Maintenance Overhauls.

Program 65 continues to add to and update its extensive set of turbine-generator outage guidelines, an EPRI product highly regarded in the industry since it was introduced more than seven years ago. *Guidelines for Reducing the Time and Cost of Turbine-Generator Maintenance Overhauls and Inspections* (2006 product no. 1012212), has grown to now encompass a seven-volume set of data delivered in a four-CD set. The Guidelines contain simple, practical tools for efficiently planning outages, including specifications and procedures necessary for planning and performing a fossil or nuclear steam turbine/generator maintenance outage. The *Guidelines,* updated yearly with additional elements defined by project advisors, educate plant staff on how to reduce time and cost of turbine-generator outages through better pre-planning and contingency planning during the outage. For more information contact Alan Grunsky (agrunsky@epri.com, 704-595-2056).

OPERATIONS AND MAINTENANCE

I&C and Automation for Improved Plant Operations (Program 68)

EPRI Details Improved Probability of Failure Analysis.

A strategic project on using equipment condition data for improving probability of failure estimations has been completed, and a technical report (1016173) is now available. The project was funded by the EPRI Technology Innovations department, managed by Program 68, with research completed by the University of Tennessee at Knoxville and the I&C Center. For more information contact Aaron Hussey (ahussey@epri.com, 704-595-2009).

Fleet-Wide Monitoring Interest Group (FWMIG) to Meet in Charlotte.

The next FWMIG meeting will be held at the EPRI offices in Charlotte, North Carolina May 13- 15. This members-only session will focus on topics discussed by users of monitoring and diagnostic technology. For more information contact Aaron Hussey (ahussey@epri.com, 704-595-2009).

Maintenance Management and Technology (Program 69)

New Training Module Focuses on Maintenance.

The third in a series of computer-based training (CBT) modules focused on maintenance practices has been released by Program 69. Product 1014107 covers fossil maintenance planning and is based on Product 1010288, "Maintenance Work Package Planning Guidance for Fossil Power Plant Personnel." CBTs released in previous years covered "Maintenance Excellence Self-Assessment" and "Predictive Maintenance Level of Awareness." For more information, contact Steve Hesler (shesler@epri.com, 704-595-2183).

OMX Initiative Nears Key Milestones.

Two key elements of the Generation Sector's Operations and Maintenance Excellence (OMX) initiative achieved milestones in the first quarter of 2008. Report 1014243, "Risk Informed Maintenance Decision Analysis Methodology," was released in December 2007. It details nine specific maintenance decisions which could be improved using a risk-informed approach. Over the next two months, EPRI staff will meet individually with participants of the OMX supplemental project to further refine the methods for employing a risk-informed approach to maintenance decisions. A process specification will be developed and documented for review by program advisors during the third quarter of 2008.

The second milestone is development of a proposed process definition for a diagnostic advisor module. It extends the value of commercial on-line monitoring to include anomaly interpretation and condition assessment. EPRI's goal is to integrate all plant information into a diagnostic algorithm, including plant process data and predictive monitoring data, operator rounds, and engineering assessment. Report 1015180, titled "Equipment Diagnostics Using Condition Monitoring Data" was released in March and contains a process definition for the diagnostic advisor. For more information, contact Steve Hesler (shesler@epri.com, 704-595-2183).

Progress Energy Hosts Plant Managers Workshop.

More than 50 participants from 11 companies were on hand Jan. 24-25 in Clearwater Florida when Progress Energy hosted the second EPRI Plant Manager's Workshop. The theme was "Effective O&M Metrics and O&M Optimization." Plant manager attendees participated in discussions of safety, environmental issues, boiler-tube failures, alarm management, and maintenance productivity. This was an important first step toward eventual collaborative development of effective leading metrics by this group in future meetings. For more information, contact Steve Hesler (shesler@epri.com, 704-595-2183).

Operations Management and Technology (Program 108)

New OMT Guidelines Available.

Several reports were delivered at the end of March, including the Work Management Guideline, Emergency Management Guideline, Clearance and Tagging Guideline, and the updated Operations Assessment Guideline. Writing and development continues on the Alarm Management Guideline and Annual Case History Report. For more information, contact Wayne Crawford (wcrawford@epri.com, 704-595-2233).

O&M Assessment Includes Outage Readiness.

As a part of a base O&M assessment conducted in January, the team was augmented to include a readiness assessment for an upcoming outage. The team also reviewed the capital budgeting process. As usual, strengths and areas for improvement were identified for use in sustaining and improving performance. Three peers from Program 108 member companies participated in the assessment, bringing current O&M experience to the team. This process continues to support members interested in improving their self-assessment process as well as providing new insights to peer evaluators who get a detailed look at another plant's performance. For more information, contact Wayne Crawford (wcrawford@epri.com, 704-595-2233).

ENVIRONMENT CONTROLS

Combustion Performance and NO_X Control (Program 71)

Plant Experiences Meeting Draws a Crowd.

More than 40 participants representing a dozen utilities were on hand when Heat Rate and Cost Optimization (P71.005) held its biennial Plant Experiences Meeting in Houston Feb. 5-6. This members-only event brings together engineers and operators to discuss what works and what doesn't in their efforts to operate their plants smoothly and efficiently. Attendees took part in sessions on turbines, balance of plant, combustion, and performance monitoring and optimization, including updates on the Production Cost Optimization Project. Highlights included Southern Company's survey of turbine troubleshooting, Great River's impressive

decade-long effort at improving heat rate at Coal Creek, and a tour of NRG's W.A. Parish Plant. For more information, contact Jeff Stallings (jstallin@epri.com, 650-855-2427).

Circumferential Cracking Project Plans More Research.

The collaborative supplemental project on causes and solutions to circumferential cracking in supercritical boilers was reviewed during a two-day meeting at Pacific Power & Light's (PPL's) Brunner Island plant. Participants included a number of PPL staff representing both the Brunner plant and the central engineering staff, as well as EPRI staff and EPRI contractors Rowan and Aptech. Key findings were disseminated, and the path forward for 2008 was defined. A final report for Phase 1 of this collaborative effort will be released in March and disseminated to the other project funders, which include Luminant, AEP, TVA, Reliant, First Energy, DTE, Southern Company, CS Energy and Tarong Energy. For more information, contact Tony Facchiano (affachia@epri.com, 650-855-2492).

Second Phase of Rowan Thermal Scanning Demo Begins.

On Jan. 30, a project kickoff meeting was held at Luminant's Martin Lake Power Plant, marking the initial phase of the second Rowan thermal scanning technology demonstration. This technology demonstration will add substantial knowledge to the ongoing Program 71 and Program 171 efforts to identify the root causes of circumferential cracking in supercritical boilers on bare and weld overlayed waterwall tubes, which reduce their availability, and will assist in the overall plan for potential mitigation methods. For more information, contact Sylvio Cardoso (scardoso@epri.com, 650-855-1056).

Integrated Environmental Control (Program 75)

On-Site Activated Carbon Production Show Promise.

Initial laboratory results of EPRI's patented Sorbent Activation Process (SAP) for on-site production of activated carbon (AC) showed the AC it produces has comparable absorption capacity to commercial products, but remains to be optimized. Given the large potential cost savings by producing AC on-site (EPRI estimates use of the SAP can potentially reduce the cost of ACI by 50% or more) and in response to the urging of participating members, EPRI simultaneously is designing and fabricating a full-scale system for trials later in 2008. For more information, contact Ramsay Chang (rchang@epri.com, 650-855-2535) or Cassie Shaban (cshaban@epri.com, 650-855-2345).

Tests show that Operational Changes can Affect Mercury Capture Rates by ACI.

While parametric tests of brominated carbon at a PRB-fired boiler had shown 70% mercury removals (for the prescribed injection rate), a later, 45-day test produced an average of only ~50%. It appears flue gas temperature had increased and the sorbent properties may have changed between these two test periods. EPRI also conducted extensive particulate matter (PM) emissions tests using Method 17 to determine the impact of the sorbent injection on PM emissions. These tests found no measurable increase in the amount of PM emitted during ACI, but visual inspection of the M17 filter catches showed the filter cake became darker as the ACI rate increased. To overcome the impact of boiler operational changes on ACI performance, EPRI also is seeking ways to enhance mercury removal effectiveness without increased balance-of-plant impacts (such as PM emissions). For more information, contact Ramsay Chang (rchang@epri.com, 650-855-2535).

EPRI's Chang Devises Test of Impact of Bromides on Wet FGD Alloy Corrosion.

Electrochemical pitting tests show bromide impact on FGD materials of construction is less than chloride for some materials, more for others, and worst when the liquor contains both chlorides and bromides. The addition of bromide salts into the boiler has been shown to be an effective way of oxidizing mercury into soluble forms that can be readily scrubbed in a downstream wet scrubber (FGD). However, bromide concentrations in the FGD liquor could be comparable to current chloride concentrations. FGD materials of construction are typically selected based on expected maximum chloride concentrations in the FGD liquor, but little information is available on the effects of elevated bromide concentrations in combination with chloride. An electrochemical pitting test has been devised to provide a rapid screening method for comparing the corrosion potential of various alloys used in FGD. For more information, contact Ramsay Chang (rchang@epri.com, 650-855-2535).

EPRI Launches Project to Develop Activated Carbon Specifications.

Much of the mercury control effectiveness and cost when using activated carbon injection depends on the performance of the activated carbon. Because more than 80 systems have been ordered to date, representing ~ 35 GW (according to the Institute of Clean Air Companies), this is a major issue for Program 75 members. They asked EPRI to develop specifications they can use to procure and test delivered sorbents. EPRI assembled a team of five power generators, DOE-NETL, and several research groups to co-manage and conduct this project. A list of 23 activated carbon sorbent tests was developed. The final product will be a report that shows how to specify activated carbon, based on the results obtained; it is scheduled to be published by the end of 2008. For more information, contact Ramsay Chang (rchang@epri.com, 650-855-2535).

Particulate & Opacity Control (Program 76)

Report Looks at "Near-Zero Emissions" Particulate Control Technologies.

This assessment was conducted to determine what might be needed to prepare for NZE emissions ahead of any required CO_2 controls, and also to provide the industry with information needed to inform air regulatory authorities. A number of particulate control OEMs indicated their equipment could achieve levels as low as 0.002lb/MBtu filterable particulate, but were not yet prepared to guarantee those levels nor ensure these levels were achievable continuously. This report provides a summary, analysis, and synthesis of in-depth discussions with leading suppliers of particulate control systems (ESPs and fabric filters [FF]) about the ability of current and developing technologies to meet extremely low, continuous particulate matter (PM) emission limits. For more information, contact Ralph Altman (raltman@epri.com, 423-899-0072).

ElectroCore Tests Show Successful Multi-Pollutant Capture.

A recently published report (1014267) documents separation efficiencies in the mid-90% range for SO_2 and mercury and over 99% for fly ash on the 5MW ElectroCore pilot at Alabama Power Company's Plant Gadsden late last year. The tests produced greatly improved particulate separation efficiencies, with some results over 99%. The previous high was 95.7%. Surprisingly, the improvement in efficiency was the result of improvements to the precharger, not to changes to the separation section of the ElectroCore. Measurements also showed separation efficiencies of 95.5% for activated carbon and 92% for the products of a pilot spray dryer installed ahead of the ElectroCore. These results, along with mercury and SO_2 capture tests measured during the program, are documented in the just published report, *Technical Evaluation of Emerging Technologies: ElectroCore Multi-pollutant System Pilot Evaluation* (1014267). For more information, contact Ralph Altman (raltman@epri.com, 423-899-0072).

Continuous Emissions Monitors (Program 77)

First Test of Mercury CEMS Field Calibrator Brings Mixed Results.

In this test of the first system to be checked, the monitor fluctuated in its response to calibration spikes. The team believes the problem is the N2 generator used as diluent in the analyzer, probably because the N2 purity varied due to changing flow. To maintain constant flow from the N2 generator, the instrument supplier has been asked to consider plumbing changes. The tests will be repeated once the supplier has approved the plumbing change. This issue affects the precision of all measurements with this supplier's systems. The first test of another supplier's system will be conducted in mid-March. For more information, contact Chuck Dene (cdene@epr.com, 650-855-2425).

Sorbent Traps Prove Useful In Mercury CEMs Calibrators Checks.

Experiments were conducted to evaluate the use of sorbent traps as a means of providing QA/QC checks of the mercury gas calibrators provided with mercury CEMs. The traps were used to test the output of both the Tekran model 3310 calibrator and a HovaQuick system. The traps were consistently higher than the Tekran unit by an average of 4.2%, while the uncertainty was only 1.8%. The average difference between the traps and the HovaQuick was only 0.6%, with an uncertainty of 1.2%. The low uncertainty suggests that the traps could be used for periodic QA/QC checks, providing a better understanding of the bias between the traps and elemental calibrator can be developed. For more information, contact Chuck Dene (cdene@epri.com, 650-855-2425).

Coal Combustion Product (CCP) Use (Program 78)

Tests Show Ash Effects on Binary and Ternary Cementitious Systems.

Concrete cracking due to the expansion caused by the reaction of the alkali cement and silica aggregate is a growing concern for both the concrete industry (performance) and power companies (partial cement replacement by ash in concrete manufacturing is the largest use of fly ash). EPRI joined with other companies and the Canadian organization CANMET to conduct long-term tests of potential concrete expansion with test bars fabricated from a range of aggregate, both Class F and Class C fly ash, and different ash replacement ratios. The tests determined amounts of low- and high-alkali ash which efficiently reduces expansion of the test bars below acceptable limits. The final report (1014271) has been released. For more information, contact Ken Ladwig (keladwig@epri.com, 262-754-2744).

Program Advisors Weigh in on Research Plans.

Members of Programs 78 and 49 learned about complementary activities to understand and manage "use" and "environmental issues." Program 78 advisors approved the 2008 R&D Plan consisting of four major thrusts – to continue the national program to demonstrate the benefits and environmental acceptability of FGD gypsum in agriculture with spring application and plantings about to take place at all six current sites; to characterize engineering properties of spray dryer/baghouse mixed product; to form a team with EERC and Trona supplier Solvay to determine best management practices for fly ash at plants that inject a sodium-based compound for SO_3 control; and to determine what is known about the impact of potassium acetate de-icer on concrete manufactured using fly ash. For more information, contact Ken Ladwig (keladwig@epri.com, 262-754-2744).

Projects Attract Interest from EPRI Non-Members.

These include uses for a spray dryer product (a potential engagement with a CCP marketing firm which believes it has found a new large-volume use of this material) and a new participant in the national network on FGD gypsum use in agriculture. EPRI also has collaborated with the USDA to quantify any mercury runoff and assess its risk to people and the ecology. For more information, contact Ken Ladwig (keladwig@epri.com, 262-754-2744).

COMMUNICATION AND OUTREACH ACTIVITIES

EPRI's Dalton Talks about CO_2 Retrofits.

Stu Dalton, director of business development for EPRI's Generation Sector, spoke at a Jan. 24 forum in Washington, DC -- sponsored by the National Commission on Energy Policy and the Institute of Clean Air Companies -- on "Existing Coal Power Plants and Climate Change: CO_2 Retrofit Possibilities and Implications." Dalton presented slides describing the challenges associated with retrofitting carbon capture and storage on existing plants, and offered an overview of promising CO_2 capture technologies. Sen. George Voinovich (R-OH) attended the forum, along with leaders from the power sector and the environmental community. The presentations from the CO_2 retrofit forum are posted at:
http://www.energycommission.org/ht/d/sp/i/499/pid/499

White House Cites EPRI for Coal Technology R&D.

EPRI was mentioned in a Jan. 25 press briefing on the second major economies meeting by Council on Environmental Quality Chairman Jim Connaughton and Undersecretary of State for Democracy and Global Affairs Paula Dobriansky. "In the course of the last two years, there's been a very intensive effort with MIT, … a group at the Electric Power Research Institute, and then some of the international sort of technical development bodies, to frame up what they think it will take for us to accelerate the effort to prove the concept of lower-carbon coal technology," Connaughton said. "I would say that we have taken on board a lot of those recommendations … because we do believe that one of the most important things the world community must do together is do what we can to prove that concept of lower-carbon coal power generation technology, and to do so as quickly as is feasible. This will take some time, but we shouldn't be waiting 50 years or 60 years to see if this is a good concept."

EPRI's Novak Talks about CCS at National Academies Workshop.

On Jan. 28 and 29, the National Academies' Fossil Energy subcommittee held a workshop in Washington, DC to investigate the status of technologies for transforming carbon sources such as coal, natural gas, and biomass into products including electricity, diesel, gasoline, and methanol. EPRI was invited to participate in the workshop to provide its perspectives on future trends in fossil electricity generation technologies. John Novak, EPRI's Executive Director of Federal and Industry Activities for Environment and Generation, participated in the workshop and gave a slide presentation on advanced coal and CO_2 capture and storage (CCS) for electricity generation. His talk addressed the role of advanced coal and CCS in a carbon-constrained future, the challenges to be overcome, the RD&D needs, and the payoff of having coal with CCS as an option to address climate change.
