

**TECHNICAL REVIEWERS' COMMENTS**  
**LRC-LXV-(65)-B**

**“Long-term Assessment of Selective Catalytic Reduction Reactor Slip Stream Performance for Utilities Burning Lignite Coal”**

Submitted by: Saskatchewan Power Corporation.

Request for: \$200,000; Total Project Costs: \$1,050,000.

Project Manager: David W. Smith, Ph.D.; Project Duration: 33 months.

1. **OBJECTIVES**

The objectives or goals of the proposed project with respect to clarity and consistency with Industrial Commission/Lignite Research Council goals are: 1 - very unclear; 2 - unclear; 3 - clear; 4 - very clear; or 5 - exceptionally clear.

**Reviewer 08-16 (Rating: 5)**

The proposed project will address an environmental nitrogen oxide (NO<sub>x</sub>) emission problem with post-combustion SCR technology for use on Ft. Union lignite coal. A previous slipstream project at the Coyote Station demonstrated that SCR catalysts suffer from plugging and deactivation. The proposed 33-month study will be conducted at Canada's SaskPower's Popular River Station.

It is anticipated that the proposed results will resolve previous SCR plugging and catalyst deactivation and would benefit ND power generators. This is an important test program that hopefully would resolve SCR deactivation and longevity issues for lignite fuels thus reducing NO<sub>x</sub> emissions to meet upcoming NO<sub>x</sub> emissions.

The project would be consistent with NDIC environmental goals.

**Reviewer 08-17 (Rating: 4)**

This project will provide data to consumers of North Dakota Fort Union lignite on whether a slip stream SCR unit can operate satisfactorily (without encountering operating problems with “severe catalyst plugging and deactivation, shorter catalyst operating life, and stickier, potentially more abrasive ashes.”) flue gas from combustion of Fort Union lignite in SaskPower's Poplar River power plant.

With this data power plant owners can assess whether an adequate solution of this issue exists or whether further development work is required.

This information is consistent with the NDIC goal of supporting continuing utilization of North Dakota lignite for power production.

**Reviewer 08-18 (Rating: 4)**

Controlling NO<sub>x</sub> emissions from the utilization of lignite is very consistent with the NDIC goals of promoting clean, efficient uses of North Dakota Lignite. The primary objectives of the proposed project are to demonstrate the application of SCR to reducing NO<sub>x</sub> emissions from the combustion of lignite, identify technical barriers to widespread deployment of SCR to lignite-fired units, and assess the operating performance of SCR with respect to catalyst deactivation and potential ammonia slip.

2. **ACHIEVABILITY**

With the approach suggested and time and budget available, the objectives are: 1 - not achievable; 2 - possibly achievable; 3 - likely achievable; 4 - most likely achievable; or 5 - certainly achievable.

**Reviewer 08-16 (Rating: 4)**

The proposed 33-month project would consist of a 1,000 acfm slipstream test program that would collect extensive data of catalyst performance. B&W has extensive experience with SCR technology and will provide the design and manage the technical program. The proposed budget is \$1,050,000 with SaskPower providing \$700,000, B&W providing \$150,000 and NDIC providing \$200,000. The time and budget seems reasonable.

**Reviewer 08-17 (Rating: 4)**

The project is well designed in terms of its approach to achieving its objectives. The proposed total budget of \$1,050,000 seems reasonable.

**Reviewer 08-18 (Rating: 5)**

Testing the SCR system for 16,000 hours represents a significant examination of the ability of the catalyst to withstand flue gases from combustion of lignite. The test matrix discussed in the proposal is very robust allowing for definitive assessment of catalyst activity and potential catalyst plugging, real-time monitoring of NO<sub>x</sub> and SO<sub>3</sub> emissions and pressure drop, and detailed analysis of material from the flue gas that may be deposited on the catalyst. The proposed budget is appropriate for the extended period of testing.

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 - well below average; 2 - below average; 3 - average; 4 - above average; or 5 - well above average.

**Reviewer 08-16 (Rating: 4)**

The methodology addresses real time measurements ranging from the inlet to the outlet of the pilot SCR. Flue gas flow rate is 1,000, significantly greater than the previous Fort Union tests in ND. Detailed analyses of catalyst performance will be provided as a function of various parametric operations and catalyst parameters.

**Reviewer 08-17 (Rating: 4)**

The proposal is very straightforward and has outlined a clear approach to the test program and evaluation of “catalyst logs” removed from the SCR reactor.

**Reviewer 08-18 (Rating: 4)**

Where possible, real-time monitoring instruments will be used to measure the emissions of key contaminants in the flue gas. The methodologies proposed are considered state-of-the-art, conforming to both industry and regulatory standards.

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address Industrial Commission/LRC goals will likely be: 1 - extremely small; 2 - small; 3 - significant; 4 - very significant; or 5 - extremely significant.

**Reviewer 08-16 (Rating: 5)**

As described in the proposal, the ND Department of Health conducted an assessment that additional testing was needed to resolve operational issues with SCR technology for Fort Union lignite. To address the SCR issues, SaskPower and B&W environmental engineers have defined a program to resolve the SCR and catalyst fouling, plugging and deactivation SCR issues in a 33-month parametric test program.

Considering EPA's call for Best Available Control Technology and the issues previously identified, the proposed SaskPower program should provide important information that would be applicable to ND's lignite-fired utilities that likely would experience fly ash related SCR plugging and deactivation problems.

**Reviewer 08-17 (Rating: 3)**

If test operations are trouble-free, the results of this project will represent a major step forward in resolving the currently open question about whether SCR can be utilized to lower NOx emissions from boilers firing Fort Union lignite. However, if operating problems are encountered, a future R&D program will have to be developed to address this problem.

**Reviewer 08-18 (Rating: 4)**

The scientific contribution of the proposed work is rated to be average because SCR is a proven technology. However, the technical contribution is extremely significant due to the importance of evaluating the application of SCR to lignite-fired power plants. Additionally, this proposed project will address the North Dakota Department of Health's concerns over the unresolved problems associated with using SCR to reduce NOx emissions from lignite-fired power plants.

5. **AWARENESS**

The principal investigator's awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

**Reviewer 08-16 (Rating: 4)**

SaskPower's Dr. Dave Smith has participated in and is aware of recent research and pilot plant SCR studies. Mr. Donald Tonn and his B&W engineers will manage the technical project and are experts on SCR technology. Published literature was identified.

**Reviewer 08-17 (Rating: 4)**

The proposal includes information about the results of SCR slipstream tests; in one case with Fort Union lignite-derived flue gas and two other cases with subbituminous coal-derived flue gas. The results with the Fort Union derived flue gas had significantly more operating problems.

**Reviewer 08-18 (Rating: 5)**

David Smith, project lead for SaskPower, has a wealth of experience in conducting test programs at the Environmental Control Research Facility (ECRF) at the Poplar River Power Station, the site of the SCR testing, including testing programs for mercury control and coal byproducts utilization. The project lead from B&W, Donald Tonn, has extensive experience with developing and implementing SCR deNOx systems in power plants. B&W is at the forefront of NOx control systems for fossil-fueled power plants.

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

**Reviewer 08-16 (Rating: 4)**

Dr. Dave Smith will serve as SaskPower's program project manager. Over his career, he has defined, supported and resolved environmental emissions ranging from mercury to CO2, SOx, NOx and combustion modifications in addition to other numerous plant environmental challenges.

B&W has demonstrated SCR technical expertise, having provided roughly 30% of the SCR technology to the domestic market. B&W will provide overall technical direction, using engineers with demonstrated technical prowess to resolve lignite-related SCR technology issues. The experience of Dr. Dave Smith and the B&W engineers have the knowledge to design and operate an SCR on a lignite-fired power plant.

**Reviewer 08-17 (Rating: 4)**

The personnel from SaskPower have extensive experience operating the specific slip-stream unit that will be utilized for this work.

The personnel from B&W have extensive experience with SCR systems. B&W notes in the proposal that they have installed 46,000 MW of SCR capacity.

**Reviewer 08-18 (Rating: 4)**

The project lead from B&W is exceptionally suited to conduct this project because of his background in NOx control and the resources available from B&W. B&W has the lead on installing, testing, and evaluating SCR on a slipstream from the SaskPower unit. The project lead from SaskPower has been involved with many similar projects and has the necessary background to complete the work on schedule. SaskPower is responsible for the test site, utilities, monitoring equipment, and access to plant operating parameters.

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any is: 1 - very inadequate; 2 - inadequate; 3 - adequate; 4 very good; or 5 - exceptionally good.

**Reviewer 08-16 (Rating: 3)**

A Ghant chart was not provided. A table providing the project timeline indicates that the project would be initiated in September 2008 and the final report provided in February 2011.

**Reviewer 08-17 (Rating: 3)**

The only milestones (see Table 3, page 20) within the operating period of the program are inspections after 4,000, 8000, 12,000, and 16,000 operating hours. There is no discussion of what will be done to deal with any operating problems that occur.

**Reviewer 08-18 (Rating: 3)**

The project management is above average listing the roles and responsibilities of the participants and indicating the deliverables. A well-defined milestone chart, schedule, and financial and communications plan were not included in the management plan.

8. **EQUIPMENT PURCHASE**

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

**Reviewer 08-16 (Rating: 5)**

*Reviewer 08-16 did not provide comments.*

**Reviewer 08-17 (Rating: 5)**

No equipment is to be purchased with NDIC funds.

**Reviewer 08-18 (Rating: 5)**

No equipment purchases were proposed.

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

**Reviewer 08-16 (Rating: 3)**

*Reviewer 08-16 did not provide comments.*

**Reviewer 08-17 (Rating: 5)**

The equipment available is excellent and will be provided by SaskPower and B&W. No NDIC funds will be used for equipment. All NDIC funds will be used for personnel to support the test program.

**Reviewer 08-18 (Rating: 5)**

The ECRF is very suited to conduct the SCR testing program, especially with determining the flue gas constituents. SaskPower has a very good track record for implementing advanced emission control technologies that have been tested at the ECRF.

10. **BUDGET**

The proposed budget "value"<sup>1</sup> relative to the outlined work and the financial commitment from other sources<sup>2</sup> is of: 1 - very low value; 2 - low value; 3 - average value; 4 - high value; or 5 very high value.

**Reviewer 08-16 (Rating: 4)**

The NDIC funds would support engineering tests.

**Reviewer 08-17 (Rating: 5)**

The amount of funds requested from NDIC is \$200,000 out of a total project budget of \$1,050,000 or slightly less than 20%. This represents very high value.

**Reviewer 08-18 (Rating: 5)**

The budget value is rated to be very high. The funding requested from the NDIC will be used to conduct the test program. The technical outcome is expected to be very significant and over 80% of the funding is from other sources.

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<sup>1</sup> "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

<sup>2</sup> Financial commitment from other sources – A minimum of 50% of the total project must come from other than Industrial Commission sources to meet the program guidelines. Support greater than 50% from Industrial Commission sources should be evaluated as favorable to the application.

## **OVERALL COMMENTS AND RECOMMENDATION:**

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

### **Reviewer 08-16 (Rating: FUND)**

In 2008, the ND Department of Health conducted a technical feasibility analysis of SCR based on an EERC slipstream test at the ND Coyote Station. The DOH concluded that additional testing would be required to address unresolved problems adapting SCR technology to a unit firing North Dakota lignite. Among the main problems identified for applying SCR to lignite units compared to others were more severe catalyst plugging and deactivation, shorter catalyst operating life, and stickier, potentially more abrasive ashes.

The proposed SaskPower test program will address the above issues in a 33-month program employing Babcock & Wilcox SCR technical expertise that, hopefully, will design an SCR reactor and catalysts that would be free of fouling and catalyst deactivation.

### **Reviewer 08-17 (Rating: FUND)**

This is an excellent proposal for a project that will collect important data on whether or not a 1000 scfm SCR slipstream unit will operate satisfactorily for 16,000 hours on flue gas extracted from a boiler at SaskPower's Poplar River Power Plant. The objective of the project appears to be to complete the test to demonstrate that the unit will in fact operate satisfactorily and avoid problems with "severe catalyst plugging and deactivation, shorter catalyst operating life, and stickier, potentially more abrasive ashes." It is implied but not explicitly stated that if the test is successful, then B&W will be able to offer and guarantee on standard commercial terms, full-scale commercial SCR units to produce flue gas from boilers burning Fort Union lignite.

What the proposal does not address is what will happen if in fact these specifically identified problems are encountered. For example, will a follow-on R&D program be developed to overcome these problems to develop solutions to the problems? Will another configuration of a slip-stream unit be required to avoid the specific operating problems encountered? Would another vendor's SCR technology offer a higher probability of success?

A fall-back plan should be developed as part of this project that could be implemented quickly if satisfactory operation cannot be demonstrated.

### **Reviewer 08-18 (Rating: FUND)**

The project has very high merits and the chances of success are extremely high. It is quite conceivable more stringent NOx regulations will be enacted in the future as a means of addressing PM<sub>2.5</sub> emissions.

While the research will be conducted in Canada, the benefits to producers and users of North Dakota lignite are outstanding. B&W is a world-wide leader in developing and applying SCR technologies to fossil-fired power plants, greatly enhancing the likelihood of success for this project.

SaskPower is a very proactive utility and at the forefront of anticipating the need for and identifying and evaluating advanced emission control technologies. I have no doubt that this project will be successful.

I strongly recommend funding this proposal.