BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	R08-19
NITROGEN OXIDES EMISSIONS FROM	)	(Rulemaking - Air)
VARIOUS SOURCE CATEGORIES:	)	
AMENDMENTS TO 35 ILL. ADM. CODE	)	
PARTS 211 and 217	)	

NOTICE OF FILING

TO: Mr. John T. Therriault
Assistant Clerk of the Board
Illinois Pollution Control Board
100 W. Randolph Street
Suite 11-500
Chicago, Illinois 60601
(VIA ELECTRONIC MAIL)

Timothy Fox, Esq.
Hearing Officer
Illinois Pollution Control Board
100 W. Randolph Street
Suite 11-500
Chicago, Illinois 60601
(VIA FIRST CLASS MAIL)

(SEE PERSONS ON ATTACHED SERVICE LIST)

PLEASE TAKE NOTICE that I have today filed with the Office of the Clerk of the Illinois Pollution Control Board the **ENTRY OF APPEARANCE OF KATHERINE D. HODGE ON BEHALF OF UNITED STATES STEEL CORPORATION, ENTRY OF APPEARANCE OF MONICA T. RIOS ON BEHALF OF UNITED STATES STEEL CORPORATION, PRE-FILED TESTIMONY OF LARRY G. SIEBENBERGER ON BEHALF OF UNITED STATES STEEL CORPORATION** and **PRE-FILED TESTIMONY OF BLAKE E. STAPPER ON BEHALF OF UNITED STATES STEEL CORPORATION,** copies of which are herewith served upon you.

Respectfully submitted,

By: /s/ Katherine D. Hodge
Katherine D. Hodge

Dated: November 25, 2008

Katherine D. Hodge
Monica T. Rios
HODGE DWYER ZEMAN
3150 Roland Avenue
Post Office Box 5776
Springfield, Illinois 62705-5776
(217) 523-4900

CERTIFICATE OF SERVICE

I, Katherine D. Hodge, the undersigned, hereby certify that I have served the attached ENTRY OF APPEARANCE OF KATHERINE D. HODGE ON BEHALF OF UNITED STATES STEEL CORPORATION, ENTRY OF APPEARANCE OF MONICA T. RIOS ON BEHALF OF UNITED STATES STEEL CORPORATION, PRE-FILED TESTIMONY OF LARRY G. SIEBENBERGER ON BEHALF OF UNITED STATES STEEL CORPORATION and PRE-FILED TESTIMONY OF BLAKE E. STAPPER ON BEHALF OF UNITED STATES STEEL CORPORATION upon:

Mr. John T. Therriault
Assistant Clerk of the Board
Illinois Pollution Control Board
100 West Randolph Street, Suite 11-500
Chicago, Illinois 60601

via electronic mail on November 25, 2008; and upon:

Timothy Fox, Esq.
Hearing Officer
Illinois Pollution Control Board
100 West Randolph, Suite 11-500
Chicago, Illinois 60601

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Chief, Environmental Bureau North
Office of the Attorney General
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One Natural Resources Way
Springfield, Illinois 62701-1271

by depositing said documents in the United States Mail, postage prepaid, in Springfield, Illinois on November 25, 2008.

/s/ Katherine D. Hodge
Katherine D. Hodge

USSC:001/Fil/COS – EOA & Pre-Filed Testimony of Larry Siebenberger and Blake Stapper

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	R08-19
NITROGEN OXIDES EMISSIONS FROM	)	(Rulemaking - Air)
VARIOUS SOURCE CATEGORIES:	)	
AMENDMENTS TO 35 ILL. ADM. CODE	)	
PARTS 211 and 217	)	

ENTRY OF APPEARANCE OF KATHERINE D. HODGE
ON BEHALF OF UNITED STATES STEEL CORPORATION

NOW COMES Katherine D. Hodge, of the law firm HODGE DWYER ZEMAN, and hereby enters her appearance in this matter on behalf of UNITED STATES STEEL CORPORATION.

Respectfully submitted,

By: /s/ Katherine D. Hodge
Katherine D. Hodge

Dated: November 25, 2008

Katherine D. Hodge
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(217) 523-4900

USSC:001/Fil/EOA - KDH

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	R08-19
NITROGEN OXIDES EMISSIONS FROM	)	(Rulemaking - Air)
VARIOUS SOURCE CATEGORIES:	)	
AMENDMENTS TO 35 ILL. ADM. CODE	)	
PARTS 211 and 217	)	

ENTRY OF APPEARANCE OF MONICA T. RIOS
ON BEHALF OF UNITED STATE STEEL CORPORATION

NOW COMES Monica T. Rios, of the law firm HODGE DWYER ZEMAN, and hereby enters her appearance in this matter on behalf of UNITED STATES STEEL CORPORATION.

Respectfully submitted,

By: /s/ Monica T. Rios
Monica T. Rios

Dated: November 25, 2008

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(217) 523-4900

USSC:001/Fil/EOA – MTR R08-9

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	R08-19
NITROGEN OXIDES EMISSIONS FROM	)	(Rulemaking - Air)
VARIOUS SOURCE CATEGORIES:	)	
AMENDMENTS TO 35 ILL. ADM. CODE	)	
PARTS 211 and 217	)	

PRE-FILED TESTIMONY OF LARRY G. SIEBENBERGER
ON BEHALF OF UNITED STATES STEEL CORPORATION

NOW COMES the UNITED STATES STEEL CORPORATION ("U.S. Steel"), by and through its attorneys, HODGE DWYER ZEMAN, and submits the following PRE-FILED TESTIMONY OF LARRY G. SIEBENBERGER for presentation at the December 9, 2008, hearing scheduled in the above-referenced matter.

Pre-Filed Testimony of Larry G. Siebenberger

I. INTRODUCTION

Good Morning. My name is Larry Siebenberger, and I am the Manager of Environmental Control at U.S. Steel's Granite City Works ("GCW"). I have been employed at GCW in various environmental and operating positions for the past 37 years. I have a BA in Chemistry and an MS in Environmental Studies from Southern Illinois University at Edwardsville.

GCW is the last fully integrated iron and steel mill in Illinois. GCW is located in Granite City, Illinois, which is in the St. Louis Metropolitan area. The facility employs approximately 2,200 employees and is one of the largest employers in the region. GCW was originally founded in 1878 and operated as Granite City Steel until 1971, when it was purchased by National Steel Corporation. National Steel Corporation filed for

Chapter 11 bankruptcy in 2002, along with many other steel producers in the United States. U.S. Steel purchased National Steel Corporation's assets in 2003.

II. OVERVIEW OF PRODUCTION OPERATIONS AT GRANITE CITY WORKS

The GCW facility includes two by-product coke batteries that produce metallurgical coke and coke oven gas, a by-product fuel with about 500-600 Btu's per cubic foot. The major components of coke oven gas consist of approximately 52% hydrogen, 26% methane, and 5% carbon monoxide. Undesulfurized coke oven gas also contains approximately 1800 ppm of hydrogen cyanide. The hydrogen cyanide contributes fuel bound nitrogen during the combustion process producing NOx in addition to the thermal NOx normally produced. As a result, coke oven gas produces higher NOx emissions than natural gas. Coke oven gas is a very valuable fuel, which is used to under fire the coke ovens themselves (approximately 40-50% of gas produced), and the remainder is used at various down stream units including blast furnace stoves, boilers, and slab reheat furnaces in lieu of a purchased fuel such as natural gas. GCW attempts to use all the available coke oven gas at these units in lieu of purchased fuels; however, depending on operating levels of the plant and the operating schedules of the down steam units, excess coke oven gas may be flared.

The next step in the production process consists of two blast furnaces that use metallurgical coke, flux (lime), iron ore and hot blast air to reduce the iron ore to molten iron. The blast furnace is a closed system. The reacted hot blast air exits the furnace as a by-product fuel called blast furnace gas. Blast furnace gas, also a valuable fuel, has a Btu content of approximately 80-120 Btus per cubic foot. The gas derives its heat content primarily from its carbon monoxide content. Blast furnace gas is a low NOx fuel. Blast furnace gas is used as a fuel in the blast furnace stoves (which heat the hot blast air used in the furnace) and the facility's boilers. During a two blast furnace operation, more blast furnace gas is produced than can be consumed. The excess blast furnace gas is flared.

The molten iron is taken to the basic oxygen furnaces where it is charged along with scrap steel into the furnace. Oxygen is blown into the iron/scrap bath where it reacts exothermically with the carbon and silicon in the molten iron resulting in a heat of liquid steel. The liquid steel is processed through a continuous caster which forms the steel into a solid slab.

The slabs of steel are taken to the hot strip mill where the slabs are charged into one of four slab reheat furnaces. As the slabs move through the slab reheat furnaces, they are heated up to rolling temperature. The slab reheat furnaces are heated by coke oven gas and natural gas. Once the slabs reach rolling temperatures, they are rolled by a series of rolling mills into a flat sheet of steel, which is rolled up into a coil called a hot roll band. Most of the steel produced at GCW is sold as hot roll bands.

Some of the hot roll bands are further processed at GCW through the pickle line which acid cleans the steel sheet and recoils it into a coil. The steel coil is then processed through a cold mill, which reduces the steel to its final thickness.

The cold reduced coil is then processed through one of the two galvanizing lines at GCW. The steel sheet is reheated in a furnace before being dipped in a bath of molten zinc or zinc and aluminum. A thin coating is left on the sheet. This product is called galvanize or galvalume. The coating offers corrosion resistance.

GCW currently operates twelve boilers. Boilers 1 through 10 were built in the 1920s and 1930s. They have approximately 60 MMBtu/hour firing capacity each. They combust coke oven gas, blast furnace gas, and natural gas. Boilers 11 and 12 are 225 MMBtu/hour boilers that also fire coke oven gas, blast furnace gas, and natural gas. The primary purpose of the boilers is to provide steam for the down stream processes, plant heating, and drive the steam turbines, which provide the blast air for the blast furnaces. The boiler loads vary depending on the level of production at the down stream processes, and the fuel blends vary depending on blast furnace operation (one or two furnace operation) and whether the hot strip slab furnaces are operating and consuming coke oven gas.

III. RECENT IMPROVEMENTS AT GRANITE CITY WORKS

Since its acquisition of the GCW in 2003, U.S. Steel has made major improvements at the facility. These improvements include the construction of non-recovery coke batteries by Gateway Energy & Coke Company, LLC, and the installation of a new cogeneration boiler ("Cogen Boiler") and turbine. The non-recovery batteries will make GCW self-sufficient with its needs for metallurgical coke. The new batteries will also provide steam for power generation. The Cogen boiler will combust blast furnace gas and a minimum amount of natural gas. Existing Boilers 1 through 10 will be shut down after full commissioning of the Cogen Boiler. The blast furnace gas consumed by Boilers 1 through 10, plus blast furnace gas that is currently flared, will be combusted in the Cogen Boiler. The steam from the Cogen Boiler, as well as the steam from the non-recovery coke batteries, will be used to generate electricity for GCW. The generation of electricity at the new turbine will be much more efficient than the power currently being generated at an outside utility and transported to the facility. Since Boilers 1 through 10 consume coke oven gas and the Cogen Boiler will not, additional coke oven gas will be available for use at the blast furnace stoves, slab reheat furnaces, and Boilers 11 and 12.

Additional projects currently being implemented at GCW, which provide emission reductions, include coke oven gas desulfurization at the existing coke by-product batteries, low NOx burner installation at the slab reheat furnaces, and replacement of the natural gas-fired coke oven gas booster pump with an electric drive pump.

IV. IMPACT OF THE ILLINOIS EPA'S PROPOSED RULE

The Illinois Environmental Protection Agency's ("Illinois EPA" or "Agency") current proposal in this proceeding would apply to the boilers, slab reheat furnaces and galvanizing lines at GCW. In the event that additional regulation of NOx emission units is required, GCW has been discussing the impact of the Illinois EPA's proposal on potentially affected emission units at the GCW facility. The Illinois EPA's proposal does not take into account the unique characteristics of the GCW boilers and slab reheat furnaces.

Specifically, the Illinois EPA's proposed limits and cited control technologies do not consider the combustion of coke oven gas and the resulting NOx emission rate, which is higher than that of natural gas. Coke oven gas NOx emissions are the result of the thermal NOx generated during combustion, and the additional NOx generated due to the fuel bound nitrogen as a result of the hydrogen cyanide content of the gas. Other unique characteristics not adequately considered include the variation in load and fuel blends that occur at the GCW boilers, the fact that not all reheat furnaces are alike, and that reheat furnaces NOx emission rates while combusting natural gas can vary widely depending on the type of product they are processing and the necessary operating temperatures.

A. Boilers

GCW does not believe that the Agency's current proposed Section 217.164(a) limit of 0.08 lbs/MMBtu for Industrial Boilers greater than 100 MMBtu/hr combustion for Natural Gas or Other Gaseous Fuels takes into account the unique characteristics of Boilers 11 and 12. Some of the unique characteristics include the combustion of a varying fuel mix of desulfurized or non-desulfurized coke oven gas in combination with blast furnace gas and natural gas. GCW has discussed with the Agency these unique characteristics and the results of a NOx control option evaluation performed by URS Corporation for Boilers 11 and 12. The URS evaluation concluded that the installation of flue gas recirculation ("FGR") in conjunction with the existing burners was the optimum NOx RACT control technology for Boilers 11 and 12. URS testimony discussing its evaluation has been filed separately. Based on the installation of FGR, GCW proposes a NOx average limit of 0.113 lbs/MMBtu for Boilers 11 and 12. This proposed limit takes into account worst case NOx fuel blends during normal operation, when one blast furnace is down and there are increased coke oven gas NOx emissions as the result of maintenance outages at the coke oven gas desulfurization facility. This limit will result in a reduction of approximately 492 tons per year of NOx emissions from current levels. *See* Exhibit A to my testimony for additional details.

B. **Reheat Furnaces**

The Illinois EPA has agreed that due to the unique characteristics of the GCW reheat furnaces, including the complexity of using both desulfurized and non-desulfurized coke oven gas (when the coke oven desulfurization unit is down for maintenance), the Low NOx Burner configuration currently being installed is RACT. While the Illinois EPA has not to date agreed, GCW has proposed an average NOx ozone season limit of 0.189 lbs/MMBtu for slab reheat furnaces 1 through 4. This limit is based on the burner manufacturer's warranty and the maximum combusted blend of desulfurized coke oven gas and non-desulfurized coke oven gas (during desulfurized maintenance outage) with natural gas. This limit will result in a reduction of approximately 476 tons per year of NOx emissions from current levels. *See* Exhibit B to my testimony for additional details.

V. **PROPOSED COMPLIANCE DATE**

The current Agency proposal has a May 1, 2010 compliance date. As stated earlier, GCW has many capital improvement projects underway. The GCW Engineering Department has a great deal of recent experience with U.S. Steel project approval procedures, engineering projects, purchasing, and installation of equipment. Based on this experience, the GCW Engineering Department has estimated that it will take at least eighteen months from the time a final rule is promulgated to complete the installation of controls. This time frame includes at least six months for initial appropriation approval for engineering, engineering design, and obtaining a construction permit. The next six months will include, after obtaining a construction permit, appropriation approval to purchase equipment, procurement, and delivery of equipment (estimated delivery of FGR fans is approximately six months). The last six months is for installation of equipment and start up. Based on this estimate, and assuming the final rule does not require items with longer delivery times, the compliance date should be at least eighteen months from the effective date of the rule.

VI. CONCLUSION

U.S. Steel respectfully requests that the Board consider this testimony and include U.S. Steel's proposed emission limits for its affected emission units in the proposed rule. Further, U.S. Steel requests that the Board allow for at least an eighteen month time frame from the effective date of the rule to comply with the final rule.

I appreciate the opportunity to present my testimony. I am happy to answer any questions.

* * *

U.S. Steel reserves the right to supplement this testimony.

Respectfully submitted,

By: /s/ Katherine D. Hodge
Katherine D. Hodge

Dated: November 25, 2008

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USSC:001/Fil/R0819/Prefiled Testimony of L. Siebenberger

EXHIBIT A

United States Steel Corporation
Granite City Works
Description of NOX RACT Emission Rate
and
Emission Reduction Calculations
for Boilers 11 and 12

U.S. Steel Granite City Works (GCW) has estimated the emissions for its boilers 11 and 12 in response to the Illinois Environmental Protection Agency's proposed rule to require that the emissions units employ Reasonably Available Control Technology (RACT) on these two units.

The Illinois Pollution Control Board has proposed revisions to Title 35 Part 217 which would require these units to meet emissions limits that have been proposed as RACT. While these units meet the definition of industrial boilers in which would be regulated under Subpart D of the proposed rule, the fuel mix that they fire is unlike that of a typical industrial boiler. Therefore, an evaluation was undertaken by URS Corporation for GCW to evaluate potential control technologies applicable to the units and estimate the resulting emissions for technologies that are found to be feasible.

The URS evaluation found that because of the unique mixture of fuels fired by the units, the only technically feasible control technology is Flue Gas Recirculation (FGR). The potential emissions and emissions reductions related to the use of FGR were evaluated. The evaluation method is described below.

RACT emissions estimates for NO_X emissions from boilers 11 and 12 were developed as three distinct components that represent three distinct operational conditions that the boilers operate under. These are:

- Normal operations,
- Operations while a blast furnace is out of service (limiting the supply of one of the fuels (blast furnace gas (BFG) used by the boilers), and
- Operations while the desulfurization unit that is being constructed to treat the coke oven gas (COG), one of the fuels used by the boilers is off-line in maintenance mode.

This analysis was done for the two boilers in combination since that is the way the steam produced by the boilers is used. Each boiler has a heat input capacity of 225 MMBtu per hour. Therefore, the analysis has been done based on the total heat input of 450 MMBtu per hour.

The calculation of estimated emissions for each of these operational modes is described below.

Normal Operations

For this analysis, normal operations were calculated as operations during those times when the two blast furnaces at the facility are in operation and providing the full potentially available BFG.

Key assumptions for this mode of operations include:

- Blast furnace maintenance time as shown in table below:

Ozone Season	Annual	
15	15	days Blast Furnace Rebuild
	55	days Blast Furnace Down (15%) of time annual basis
23		days Blast Furnace Down (15%) of time ozone season basis
2	2	days maintenance outage
40	72	days Total Maintenance Outage

- a fuel mix on the boilers of:
  - 25% natural gas (NG)
  - 35% BFG
  - 40% COG
- a capacity factor of 100%
- controlled NO_X emission rates (lbs/MMBtu) of:
  - 0.084 NG
  - 0.0288 BFG
  - 0.144 COG

Furnace Downtime Operations

- Furnace downtime
  - 15 days furnace rebuild
  - 15% downtime per furnace (55 days for annual and 23 days for ozone season)
  - 2 days maintenance outage
- Fuel Mix
  - NG 40%
  - COG 60%
- Capacity factor 40%
- Same emission rates per fuel as for normal operations

Coke Oven Gas Scrubber Maintenance Mode

- 35 days per year
- occurs when COG represents 60% of the fuel mix
- since NO_X emissions are higher in this mode of operation, emissions are treated as a delta based on the COG emissions rate without COG desulfurization minus COG emission rate with COG desulfurization
    - COG emission rate with desulfurization 0.144
    - COG emission rate without desulfurization 0.336

Baseline conditions were calculated using the same assumptions presented above but with the following emission rates in lb/MMBtu:

- 0.3 NG
- 0.066 BFG
- 0.729 COG

Results

Based on the assumptions and calculations shown above and the resulting ozone season controlled emission rate, the following emission reductions are anticipated due to the installation of FGR on Boilers 11 and 12.

	NO_X Emissions (tons/year)		NO_X Emissions (tons/ozone season)	
	Baseline	Controlled	Baseline	Controlled
Normal Operations	616.6	179.4	237.8	54.1
Furnace Downtime Operations	86.69	17.6	48.16	10.37
COG Desulfurization Down Delta		14.5		14.52
Total	703.3	211.6	286.0	79.0
Reduction in Emissions		491.7		207.0

GCW proposes to meet NO_X requirements by averaging emissions between boilers 11 and 12 and among fuels and meet an average controlled rate of 0.113 lb/MMBtu.

EXHIBIT B

United States Steel Corporation
Granite City Works
Estimation of NOx Emissions
and
NOx Emission Reductions
for Slab Furnaces 1, 2, 3 and 4

U.S.Steel Granite City Works (GCW) has estimated the emissions for its slab furnaces 1, 2, 3, and 4 in response to the Illinois Environmental Protection Agency's proposed rule to require that the emissions units employ Reasonably Available Control Technology (RACT) on these four units.

The Illinois Pollution Control Board has proposed revisions to Title 35 Part 217 which would require these units to meet emissions limits that have been proposed as RACT. These units meet the definition of recuperative reheat furnaces which would be regulated under Subpart H of the proposed rule. Therefore, an evaluation was undertaken by GCW to evaluate potential control technologies applicable to the units and estimate the resulting emissions for technologies that are found to be feasible.

The evaluation found that for these particular units, the only technically feasible control technology is the installation of low NO_X burners. The potential emissions and emissions reductions related to the use of low NO_X burners were evaluated. The evaluation method is described below.

RACT emissions estimates for NO_X emissions from slab furnaces 1 through 4 were developed based on a set of key assumptions. These are:

- Emission rates developed by manufacturer of low NO_X burners designed for these furnaces (Bloom);
-

Furnace No.	Projected Thermal Input (MMBtu/yr)	Ozone Season Emission Rate (lb/MMBtu)
1	1,654,304	0.162
2	1,654,304	0.162
3	1,654,304	0.214
4	2,206,238	0.212

- Furnace downtime for maintenance is assumed to occur during the ozone season;
- COG desulfurization is down for maintenance 35 days per year (resulting in higher fuel bound nitrogen) during the ozone season.

Results

- Recent emission reduction permit provided NO_X emission reductions of 428 tons per year (permit limit is 724.09 tons/year);
- NO_X RACT proposal would further limit NOX emissions to a total of 676 tons per year;

Furnace No.	Projected Thermal Input (MMBtu/yr)	Average Emission Rate (lb/MMMBtu)	Annual Emissions (tons)
1	1,654,304	0.189	156
2	1,654,304	0.189	156
3	1,654,304	0.189	156
4	2,206,238	0.189	208
Total	7,169,150		676

- Low NO_X burner system based on compliance with NO_X RACT would reduce annual emissions by another 48 tons per year;
- Total NO_X emissions reductions of 476 tons per year.

GCW proposes to meet NO_X requirements by averaging emissions between slab furnaces 1 through 4 and meet an average controlled rate of 0.189 lb/MMBtu.

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AMENDMENTS TO 35 ILL. ADM. CODE	)	
PARTS 211 and 217	)	

PRE-FILED TESTIMONY OF BLAKE E. STAPPER
ON BEHALF OF UNITED STATES STEEL CORPORATION

NOW COMES the UNITED STATES STEEL CORPORATION ("U.S. Steel"), by and through its attorneys, HODGE DWYER ZEMAN, and submits the following PRE-FILED TESTIMONY OF BLAKE E. STAPPER for presentation at the December 9, 2008, hearing scheduled in the above-referenced matter.

Pre-Filed Testimony of Blake E. Stapper

I. INTRODUCTION

Good Morning. My name is Blake Stapper, and I am a professional engineer in the State of Texas. I have over twenty years of experience in the area of regulatory compliance and combustion engineering and have been employed by URS Corporation ("URS"), an environmental consulting firm, since 2000. I have a BS and MS in mechanical engineering from the University of Texas and University of California, respectively. A copy of my resume is attached to my testimony.

My testimony today focuses on the NOx control options that URS evaluated for Boilers 11 and 12 located at U.S. Steel's Granite City Works ("GCW") in Granite City, Illinois. I will describe the various NOx control options that URS evaluated and explain why such control options are or are not reasonable NOx control technologies for these boilers.

II. BACKGROUND

Boilers 11 and 12 are field erected boilers rated at a steam flow of 150 klb/hr. Boiler 11 is a Combustion Engineering (ABB) corner fired boiler with a single level of burners. Boiler 12 is a front wall fired boiler built by Riley with two circular burners. Both boilers utilize air heaters for heat recovery and to assist in flame stability when burning blast furnace gas ("BFG"). Both boilers are designed to fire natural gas ("NG"), coke oven gas ("COG") and BFG either separately or in combination. Both COG and BFG are fuels that present special combustion and pollution control issues. COG contains fuel nitrogen components, primarily hydrogen cyanide ("HCN"). During combustion, a fraction of the HCN is converted to NOx, making the COG a relatively high NOx emitting fuel. In regards to BFG, it has a very high concentration of inerts and does not contain fuel nitrogen components like HCN, and consequently BFG is an inherently low NOx fuel. However, BFG has a very low heating value (about 112 Btu/ft3), and thus, BFG is difficult to burn. Since both COG and BFG are process gases, particulates can be present, which precludes burner designs having small orifices.

As discussed in more detail in the following sections, URS evaluated both combustion modifications options and back-end control technologies for Boilers 11 and 12. The combustion modifications evaluated included flue gas recirculation ("FGR") applied to the existing burners and burner replacement with and without FGR. The back-end control technologies evaluated included Selective Non-Catalytic Reduction ("SNCR").

III. FLUE GAS RECIRCULATION

Based on the URS experience with various fuels, boilers, burners, and FGR systems, a FGR addition to the existing burners was selected as the optimum NOx control technology for Boilers 11 and 12. FGR, without burner replacement, has been successfully applied to both corner fired boilers, which are similar to Boiler 11, and multi-burner front wall fired boilers, which are similar to Boiler 12. In similar boilers firing either NG or refinery gas, NOx reductions ranging from 60% to 70% were obtained with FGR.

The amount of flue gas that may be recirculated is limited by flame stability. Increasing amounts of FGR reduce the concentration of oxygen in the combustion air, and replaces it with the inert gases from the flue gas (primarily nitrogen and carbon dioxide). At lower levels, the recirculated flue gas acts as a heat sink, causing the flame temperature to decrease, and resulting in lower thermal NOx formation. However, as the amount of FGR increases, the inerts increase to the point that it is no longer possible to maintain a stable flame. This point of instability (and the corresponding amount of FGR that may be safely introduced) varies based on the burner design.

The existing burners on Boilers 11 and 12 should be able to accept a significant amount of FGR (20%), since the burners already fire BFG with very little support fuel. This is because the BFG is composed of a significant amount of inert gases (over 60% nitrogen and carbon dioxide, combined). The presence of the inert gases depresses the flame temperature, and reduces the thermal NOx formation. This is the same mechanism, by which FGR reduces NOx emissions, only the inert gases (the nitrogen and carbon dioxide in the flue gas) are introduced along with the combustion air. As such, BFG is effectively a gaseous fuel with the equivalent of significant FGR. Since the existing burners can burn large quantities of BFG, addition of FGR when burning a high percentage of COG or NG should not present any combustion issues. Since the boilers are designed for the flue gas flow present with BFG, the addition of FGR when firing NG or COG will also not present any boiler heat transfer issues or affect the boiler efficiency.

Since the BFG has the equivalent of significant FGR, it would not be wise to implement additional FGR when firing a high fraction of BFG, as it would not be possible to maintain a stable flame. Due to the inherently low-NOx combustion of the BFG, this will not significantly impact the overall reduction obtained by the implementation of FGR.

Another factor that makes FGR an ideal NOx control technology for the GCW boilers is that the amount of FGR added can easily be controlled based on the measured fraction of NG, COG, and BFG used, allowing NOx control to be maximized when firing NG or COG, but not cause flame stability issues when firing BFG.

IV. <u>BURNER REPLACEMENT</u>

URS also evaluated whether replacing burners was a viable option for controlling NOx from Boilers 11 and 12 and determined that burner replacement was not a viable option for several reasons. First, there is very limited recent experience in this country applying "low NOx burners" technologies to steel plant gases. In addition, the specialized fuel requirements at a steel plant, particularly for BFG, mean many boiler burner technologies that have been developed for NG and/or refinery gas are not suitable for BFG applications. Application of a burner design, unproven for steel plant gases could result in a non-functional boiler and/or a boiler explosion. Burner replacement as a control option also was rejected for the GCW facility because Boiler 11 is a corner (tangentially) fired boiler. Since the existing burners for this unit are inherently low NOx, the application of circular low NOx burners would mean a total rebuild of the boiler.

Further, low NOx burners do not necessarily provide significant NOx reductions alone, but must be combined with FGR. When emissions from low NOx burners with FGR are compared to emissions from conventional burners with FGR, in most cases, the NOx reductions for a given FGR rate are the same. In the URS boiler database, which consists of NOx data from hundreds of boilers with FGR applied to the existing burners and retrofits of low NOx burners with FGR, there is no statistical difference in the NOx reductions achieved for a given FGR rate when the burners were replaced versus application of FGR alone.

V. SNCR

SNCR systems entail the injection of a reducing agent (ammonia/urea) into the flue gas stream to produce a NOx reducing atmosphere at proper temperatures. These systems are common on large utility boilers. SNCR systems require ample residence time and good mixing of ammonia and flue gases at the ideal temperature range for satisfactory NOx reductions to occur. If these conditions are not met, it can result in higher NOx, or the emission of unreacted ammonia ("ammonia slip").

The ideal temperature range for the SNCR reactions to occur ranges from about 1,700°F to 2,100°F. If the ammonia/urea is injected when the temperature is higher, it will be oxidized and will result in higher NOx emissions. If the ammonia/urea is injected when the temperature is too low, the reaction will not occur, and ammonia will be emitted from the stack. Improper mixing of the ammonia/urea and NOx can also result in poor SNCR performance. If the molar ratio of ammonia/urea to NOx is too high at a given location, then the excess ammonia will be emitted.

In sulfur-containing fuel firing applications, ammonia slip results in the creation of ammonium compounds which are emitted as condensable particulates. These compounds typically condense at temperatures that are commonly found in the air heaters, and the deposits that form can lead to plugging, fouling, and corrosion. Air heater pluggage increases the pressure drop and acts to reduce the maximum steam production from the boiler. Air heater fouling results in decreased thermal efficiency of the boiler process. Air heater corrosion decreases the equipment life, and results in more frequent maintenance. Each of these outcomes will ultimately require that the unit be shut down. Recent studies on utility boilers that inject ammonia when firing sulfur-containing fuels suggest that even very low amounts of ammonia slip may negatively impact the air heater.

Boilers 11 and 12 are not good candidates for SNCR application because their operating characteristics are not consistent with the characteristics required for SNCR operation. As discussed in more detail below, the specific characteristics of the boiler operation that preclude SNCR as a viable control option include variation in steam load, changes in the bound-nitrogen content of the fuel, fluctuations in fuel heating value, and the sulfur content of the COG.

The steam loads for Boilers 11 and 12 varies significantly, because they are affected by other parts of the process. When both blast furnaces are in operation, the steam demand is high. However, when only one blast furnace is in operation, the steam demand is relatively low. There are other parts of the process that require steam, which cause the boiler load to swing. When the load changes, the flue gas temperature also changes. As such, the location of the optimum temperature window for the SNCR reactions changes. Since the ammonia/urea injection grid is fixed, the flue gas temperature at the injection point may not be ideal. On large utility-scale boilers, multiple injection locations may be used to overcome this problem, but it is not practical on smaller units, such as GCW's Boilers 11 and 12.

The COG contains bound nitrogen, in the form of HCN, which is of particular concern when the H_2S scrubber is out of service for maintenance purposes. The presence of bound-nitrogen compounds in the COG means that changes in the COG firing rate will also produce dramatic changes in the uncontrolled NOx concentration. Variations in the NOx cause an improper molar ratio of ammonia/urea to NOx, resulting in either higher NOx emissions or ammonia slip as the COG component of the fuel changes.

The heating value of the three fuels being fired in Boilers 11 and 12 is quite different, with the BFG having a heating value about one tenth that of NG, and the COG being somewhere in between. As the fuel blend being fired in the boilers varies, the flame temperature in the boiler fluctuates. The fuel blend also affects mass flow rate through the boiler, which is much higher for the BFG than for NG. The changes in the flame temperature and mass flow rate not only cause the location of the ideal SNCR injection temperature window to change, they also cause the NOx mass emission rate to fluctuate. Variations in the NOx cause an improper molar ratio of ammonia/urea to NOx, resulting in either higher NOx emissions or ammonia slip during fuel composition transitions.

The scrubbed COG contains a significant amount of hydrogen sulfide and other sulfur-containing compounds. These concentrations are much higher when the boilers are being operated while the H_2S scrubber is out of service for maintenance purposes. In either case, some of the sulfur compounds will react with the ammonia/urea that is injected to form condensable ammonium sulfates. Ammonium bilsulfate will condense at the temperatures present in the air heater. As such, it will form deposits on the air heater surfaces, and will negatively affect the boiler operation, as described previously. Ammonium sulfate production is also an issue that is particularly important in Granite City since any additional fine particulate that is produced by combustion processes and ultimately emitted to the atmosphere has the potential to exacerbate $PM_{2.5}$ nonattainment issues.

VI. CONCLUSION

The NO_X control measure that is best applied to the GCW Boilers 11 and 12 is FGR. This NO_X control can result in significant pollutant reductions while minimizing potentially adverse effects on boiler operation. Other control approaches considered for these boilers included SNCR and low NO_X burners. Neither of these controls offer any advantages either singularly or in combination with FGR when compared to application of FGR alone. In fact, particularly SNCR has several distinct disadvantages including the potential to create additional PM emissions – a result that would be directly at odds with the Illinois Environmental Protection Agency's goal of reducing PM emissions in order to attain the $PM_{2.5}$ National Ambient Air Quality Standard.

Thank you for allowing me the opportunity to present my testimony. I am happy to answer any questions.

* * *

U.S. Steel reserves the right to supplement this testimony.

Respectfully submitted,

By: /s/ Katherine D. Hodge
Katherine D. Hodge

Dated: November 25, 2008

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USSC:001/Fil/R0819/Prefiled Testimony of B. Stapper

URS

Blake E. Stapper, PE

Principal Engineer

Overview

Mr. Stapper has worked in the field of regulatory compliance and combustion engineering for 20 years, and currently serves as the manager of the Air Pollution Control team for URS' Carolinas operation. During his career, he has performed and managed numerous combustion and air pollution control projects in the refining, chemicals, utility, metals, forest products, and aerospace industries. The primary focus of these projects has been to quantify and reduce the NO_x emissions from a wide variety of sources. He has managed air permitting projects for utilities, and developed and taught training programs for both air pollution control and regulatory applicability. Mr. Stapper has performed numerous BACT analyses for multiple source types, including boilers, process heaters, IC engines, turbines, flares, and painting facilities. He has worked to develop innovative NOx control technologies, and has conducted evaluations to select the most suitable technology for a particular application. He has also performed optimization projects to improve efficiency, both for individual sources, and for entire facilities. His responsibilities have included all aspects of these projects, including planning, testing, design, implementation, and project management.

Areas of Expertise

NOx, Combustion, Air Pollution Control, Regulatory Compliance, Compliance Strategy, Emissions Monitoring and Prediction

Years of Experience

With URS: 16 Years

With Other Firms: 4 Years

Education

MS / 1989 / Mechanical Engineering / University of California, Irvine

BS / 1986 / Mechanical Engineering / University of Texas @ San Antonio

Registration/Certification

1993 / Registered Professional Engineer / TX / 76087

Chronology

Principal Engineer, URS, Charlotte, NC, 2007 to present
Unit Leader, URS, Austin, TX, 2002 to 2006
Project Manager, URS, Austin, TX, 2000 to 2002
Project Manager, Pegasus Technologies, Austin, TX, 1998-2000
Senior Engineer, Radian International, Austin, TX, 1990-1998
Research Assistant, The University of California – Irvine, 1987-1989
Research Engineer, SwRI, San Antonio, TX, 1986-1987

Project Specific Experience

Some specific examples of projects in which Mr. Stapper has been involved are as follows:

- **Project Manager, Emissions Control Study.** Mr. Stapper is currently working on a project to evaluate the emission control equipment that would provide the best solution for a facility in Texas that is burning petroleum coke in horizontal kilns. The objective of the project is to identify a combination of particulate, SO2, and sulfuric acid controls that would allow the facility relief from the regulatory requirements that currently constrain their operational flexibility. The deliverable for this effort is a recommendation and budgetary cost estimate, for the purpose of securing authorization to develop an Authorization For Design engineering package.

- **Project Manager, NOx Control Evaluation for Clean Air Interstate Rule (CAIR) Compliance.** Managed an evaluation of a 430 MW tangentially-fired utility boiler, to determine the applicability and costs of a range of NOx control technologies. The goal of the project was to recommend how to implement these technologies in stages to provide the most cost-effective solution for complying with the CAIR Phase I and Phase II NOx emission allowances.
- **Task Leader, Petcoke Gasifier Permit Application.** Mr. Stapper served as the task leader for the analysis of the Best Available Control Technology (BACT) for the emissions sources at a proposed petroleum coke gasification facility in Texas. The sources that were evaluated included boilers, thermal oxidizers, material handling, storage tanks, and IC engines.
- **Project Manager, Low-NOx Burner Retrofits for 12 Process Heaters.** Managed a project to engineer, procure, and provide construction oversight for the installation of low-NOx burners and burner management systems on twelve process heaters. Mr. Stapper was responsible for coordinating the work of URS staff from multiple offices with a number of subcontractors, in order to meet the regulatory compliance date of June 1, 2006. All twelve heaters were certified as compliant prior to the deadline.
- **Project Manager, Boiler Induced Flue Gas Recirculation (IFGR) Retrofit.** Managed the design of an IFGR system on a steam boiler at NASA. The goal of the project was to reduce NOx emissions to 0.035 lb/MMBtu using the existing forced draft fan. The boiler control system was also upgraded. The deliverable was the construction bid package for the retrofit.
- **Project Manager, NOx Controls for Rule 4306 Compliance.** Managed a project to assess the necessary modifications to 43 refinery combustion sources for compliance with the San Joaquin Valley Unified Air Pollution Control District Rule 4306. Mr. Stapper was responsible for the technical evaluation of the process heaters for retrofit with ultra low-NO_x burners. Two boilers require the installation of induced flue gas recirculation (IFGR) to meet the new compliance limits. A number of the

larger boilers and process heaters will require SCR. The scope of the project was to determine what controls should be applied to each unit, and to provide a total installed cost estimate.

- **Project Manager, Ultra-low NOx Burner Retrofit for NOx SIP Compliance.** Managed the installation of an ultra-low NOx RMB burner on two gas-fired steam boilers to achieve 9 ppm NOx emissions. The turn-key EPC project included an upgrade of the boiler burner management system, the replacement of the forced-draft fans, and the installation of variable frequency drives to increase the operating efficiency. The first retrofit is complete, and installation on the second boiler is underway.
- **Project Manager, Low NOx Burner Retrofits.** Managed the implementation of ultra-low NOx burner retrofits on a boiler and two process heaters for a chemical manufacturer with two sites in the HGA The first part of this effort was to develop a SIP compliance evaluation. This study determined the lowest cost options for NOx control technologies at each of the two sites, and also developed a plan that demonstrated the potential savings if the two sites traded NOx credits as if they were a single account. A project schedule was also developed so that the projects could be spread out over the duration of the five year interim compliance period.
- **Project Manager, SCR Troubleshooting.** Evaluated performance problems with the Selective Catalytic Reduction (SCR) systems on four GE LM6000 simple cycle gas turbines. Although the units had only operated about 1,000 hours since startup, the SCRs had not been able to demonstrate the necessary performance, based on outlet NOx emissions. URS was contracted to investigate the extent of the performance problem, to identify the causes of the operating problems, and to recommend corrective actions. The results showed that the SCR was not able to achieve the performance guarantee for outlet NOx and NH3 slip. The data showed that the ammonia vaporization skid was undersized, and further suggested that the performance problem was caused by premature catalyst deactivation. URS provided recommendations for corrective action, which were subsequently implemented.
- **Project Director, Passive FTIR Phase I Testing of Simulated and Controlled Flare Systems.** Directed the technical tasks for an evaluation of the use of passive Fourier transform infrared radiometry for measuring emissions from process flares. Flare emission levels are not well understood due

to the difficulty in making traditional emissions measurements. The project consisted of the development of a Quality Assurance Project Plan (QAPP), an analytical study of the technology to estimate detection limits, along with field testing on a simulated flare plume and an actual process flare. Mr. Stapper's responsibilities included the overall management of the technical aspects of the project, which included serving as the leader of the testing, data analysis, and reporting tasks.

- **Project Manager, Boiler Optimization.** Testing, modeling and installing a neural network control system on a coal-fired, 590 MW tangentially-fired CE boiler with SOFA and CCOFA. Initial testing demonstrated a NOx reduction of 20%, with a simultaneous 50 Btu/kWh improvement in unit net heat rate.
- **Project Manager, Utility Boiler Optimization .** NOx and heat rate improvement project on a gas-fired 430 MW tangentially-fired CE boiler. Testing included an evaluation of reduced air operation at low loads and an assessment of the optimum burner configurations to achieve minimum NOx at low loads. The recommended changes to the unit's operating procedures reduced heat rate by 0.5% and lowered NOx emissions by 15%.
- **Project Manager, Boiler Optimization and Emissions Prediction.** Testing, modeling and installing a neural network control system on a coal-fired, 590 MW tangentially-fired CE boiler. The goal of this project was to reduce NOx emissions as much as possible with no negative impact on heat rate. Testing was conducted to determine the effects of reduced excess oxygen, mill biasing and air staging. The system demonstrated an 18% NOx reduction, with a 1.9 percent heat rate improvement.
- **Project Manager, Consulting Services to Evaluate NOx and SO2 Emissions Control for Municipal Waste Gasifier.** Managed an evaluation of the performance claims for a municipal solid waste gasification facility. Mr. Stapper was responsible for reviewing the documentation provided by the gasifier vendor for the combustion process to gasify the MSW, along with the post-combustion controls for removal of particulate, SO2, and NOx. The results of the evaluation showed that the gasifier project was capable of performing at the specified production rate, while achieving the project goals for emission levels.
- **Task Leader, SCR Pilot Demonstration.** Pilot study to demonstrate the applicability of a selective catalytic reduction system (SCR) on a high-dust, coal-fired utility boiler. Responsible for planning testing activities, analyzing the results, and reporting.

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- **Task Member, SNCR Demonstration.** Demonstration of a selective non-catalytic reduction system (SNCR) for NOx reduction on a 185 MW oil-fired boiler. Responsible for conducting test program and for collective process and emissions data. Collected and analyzed ammonia samples to equate SNCR NOx reduction performance with ammonia slip.
- **Task Member, System-wide NOx Control Evaluation.** Evaluated NOx control technologies for all the sources at a utility. Specific responsibility was to assess the effectiveness of the selective non-catalytic NOx reduction technology on approximately 50 units.
- **Task Leader, Amine Incinerator BACT Analysis.** Recommended the best available control technology (BACT) for NOx on a new amine incinerator at a Gulf Coast chemical plant. The project tasks included a review of the waste stream to estimate the emissions loading, an evaluation of the available NOx control technologies, and the identification of the most cost effective control equipment.
- **Project Director, Projected Emissions from BIF Boiler.** Analyze the potential emissions from a proposed BIF boiler (for incinerating hazardous wastes) at a Gulf Coast refinery. The project required an assessment of the existing BIF units and their respective waste streams. This was coupled with the operating characteristics of the proposed unit in an attempt to predict the emissions once it was installed.

Professional Societies / Affiliates

Air and Waste Management Association
American Society of Mechanical Engineers
Combustion Institute
Institute for Liquid Atomization Spray Studies
Carolinas Air Pollution Control Association

Specialized Training

MS / 1989 / Mechanical Engineering / University of California, Irvine
BS / 1986 / Mechanical Engineering / University of Texas @ San Antonio
URS Project Manager Certification, 2005

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Publications

John Wester, Blake Stapper and Madhu Ramavajjala, "SCR Operational Issues at Austin Energy's Sand Hill Energy Center", presented at the 105th Meeting of the Plant Design and Operating Committee, Austin, TX, July 2002.

Teresa L. Wilson, Blake E. Stapper, G. Dale Roberts and Don Scruggs, "Application of a Neural Network Based, Closed-Loop Control Optimization System to a Load-Following Utility Boiler, to be presented at PowerGen 2000, Orlando, FL, November 2000.

Blake E. Stapper and R.C. Booth, "Advances in the Application of Neural Network Systems for Controlling NOx and Heat Rate in Utility Boilers", AWMA 93rd Annual Conference and Exhibition, Salt Lake City, UT, June 2000.

Brad J. Radl and Blake E. Stapper, "Advanced Control and Operating Strategies for Power Generation Companies", EPRI-DOE-EPA Combined Utility Air Pollutant Control Symposium, Atlanta, GA, 1999.

Micheal Lewis, Monte Gottier, and Blake Stapper, "Emission Solutions Through Optimization", EPRI-DOE-EPA Combined Utility Air Pollutant Control Symposium, Washington, D.C., 1997

Scott Briggs, Blake Stapper, and Walt Crow, "A Predictive Emissions Monitoring System (PEMS) for a Paper Mill Power Boiler", TAPPI Environmental Conference & Exhibit, Minneapolis, MN, 1997

Blake E. Stapper, Gordon C. Page, Robert R. Horton, and Ted S. White, "Compliance Optimization Modeling Systems for Industrial Boilers", CIBO Ninth Annual NOx Control Conference, Hartford, CT, 1996

Blake E. Stapper, Thomas P. Nelson, Ronald D. Bell, and S. Peter Barone, "A Low- NOx, High-DRE Burner for Co-firing Liquid Waste with Natural Gas", AFRC Fall International Symposium, Monterrey, CA, 1995

Huang, C., Hargis, J., Fuller, L., Mallory, R., Stapper, B., and Cichanowicz, E., "Status of SCR Pilot Plant Tests on High Sulfur Coal at Tennessee Valley Authority's Shawnee Station," presented at the 1993 EPRI/EPA Joint Symposium on Stationary NOx Control, Miami, FL

B. E. Stapper and G. S. Samuelsen, "An Experimental Study of the Breakup of a Two-Dimensional Liquid Sheet in the Presence of Co-flow Air Shear", AIAA-90-0461, Gas Turbine and Aeroengine Congress and Exposition, Brussels, Belgium, 1990