

Pulverized Coal and Natural Gas – Dual Fuel - Low NO_x Burners & OFA System

CLIFFS NATURAL RESOURCES – Silver Bay Power Company

Owner/Operator

CLIFFS NATURAL RESOURCES
Silver Bay Power Company – Unit 1

Completion Date

Spring 2015

Services Provided

- Pre mod inspection & evaluations
- CFD modeling
- Burner design
- OFA design
- Procurement
- Installation technical direction
- Startup, commissioning
- Combustion tuning

Pre-Installation

Boiler Performance

100% PRB Pulverized Coal
Burner Heat Input = 87 mmBtu/hr
NO_x = 0.65 lb/mmBtu
CO ~ 75 ppm
UBC < 1%

100% Natural Gas
Burner Heat Input = 90 mmBtu/hr
NO_x = 0.35 lb/mmBtu
CO ~ 20 ppm

Post-Installation

Boiler Performance Test

100% PRB Pulverized Coal
Burner Heat Input = 87 mmBtu/hr
NO_x = 0.27 lb/mmBtu
CO < 45 ppm
UBC < 1%

100% Natural Gas
Burner Heat Input = 90 mmBtu/hr
NO_x = 0.18 lb/mmBtu
CO < 25 ppm



Project Summary

Power & Industrial Services provided boiler inspections, baseline evaluations, CFD modeling support, engineering, design, complete fabrication, technical direction of installation, start-up commissioning and performance testing to Silver Bay Power Company for the Unit 1 NO_x and combustion optimization project. All project objectives were achieved including equipment delivery, ease / accuracy of installation despite very congested work areas and meeting performance guarantees for NO_x, CO, and UBC. Also significant improvements were achieved related to igniter and scanner performance.

Project Features

- Pre-modification Computational Fluid Dynamic (CFD) Modeling with post-modification CFD model validation
- Dual Fuel (PRB & NG) Low NO_x Burners, designed and manufactured by Power & Industrial Services, which incorporated existing oil igniters and existing flame scanners
- Elimination of high maintenance / high pressure drop coal nozzle metal Impellers by use of P&I ceramic Ropebreaker technology
- Overfire Air (OFA) Ports, Bent Tube Panels and ancillary equipment designed and manufactured by Power & Industrial Services
- Innovative OFA design which includes OFA ports optimally located on furnace rear wall with the supply ducts routed through the Economizer Exit Flue Gas Duct due to orientation of furnace and convection pass
- Technical direction of installation with on-sight availability of 3D cad models
- Start-up commissioning and combustion optimization
- Performance testing

Project Description

CLIFFS NATURAL RESOURCES – Silver Bay Power Company retained Power & Industrial Services to engineer, design, manufacture, and technically direct the installation of components for a combustion system upgrade project that included the installation of six (6) low NO_x burners and a new five (5) port

(continued)



overfire air system on Unit 1. The unit is a front wall fired, 450000 lb/hr steam flow, B&W boiler capable of firing 100% low sulfur PRB coal, 100% Natural Gas or co-firing coal / natural gas.

The main goal of the project was to achieve required NO_x, CO and UBC guarantee limits and also improve reliability / performance of existing oil igniters, scanners and gas firing components.

Challenges overcome during the project included placing the OFA Ports at the optimum elevation on the furnace rear wall. The convection pass was adjacent to the furnace with only the furnace rear wall tubes separating the furnace from the convection pass. The solution was to provide a robust OFA supply duct system, through the Economizer Exit Gas Duct, with the OFA ports located directly below the Economizer Tube Bank.

Another challenge was to eliminate the existing coal Impellers in each coal nozzle while achieving optimum burn out without target wall flame impingement. Impellers are considered to be a high maintenance item due to metal erosion and/or heat damage. Elimination of the metal Impellers was successfully accomplished by use of P&I's Ropebreaker technology which uses a Nitride Bonded Silicon Carbide (NBSC) ceramic Ropebreaker attached to the burner elbow flatback.

