2013 **Title:** **Biomass Replaces Coal at the Hibbard Power Generation Facility**

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ABSTRACT:

Minnesota Power (MP) operates the Hibbard Power Generation Facility in Duluth, MN. At Hibbard, superheated steam for power generation is supplied by two identical boilers (No. 3 and No. 4 Boilers). The units, originally supplied in the 1950's to burn pulverized coal, were converted in 1985 to generate 300,000 lb/hr of superheated steam by firing a mixture of wood and stoker coal (in a 60:40 heat input split) on a traveling grate. The boilers fire Powder River Basin (PRB) stoker coal and biomass fuel which consists of a mix of purchased wood wastes, railroad cross-ties, and short fiber residue. Along with power generation, the plant also provides low pressure steam to the nearby NewPage paper mill.

Historically, the boilers had not been able to reliably achieve the design biomass firing rates. Increased biomass firing (with a lowering of PRB coal firing) would lead to excessive carryover, high amounts of unburned char in the fly ash, high flue gas exit temperatures, and limited induced draft (ID) fan operating margin.

MP desired to increase the biomass firing rates and to eventually eliminate coal firing and generate 300,000 lb/hr of steam from biomass firing only. MP contracted Jansen Combustion and Boiler Technologies, Inc. (JANSEN) to meet their goals through a phased program of evaluation, engineering, and equipment supply. The evaluation, including a site visit to collect boiler operating data, engineering analysis, and Computational Fluid Dynamics (CFD) modeling, identified a number of factors that prevented higher biomass firing rates.

Non-uniform fuel delivery and an ineffective overfire air (OFA) system were the main causes for high char and ash carryover. High flue gas velocities in the generating bank (GB) outlet ash hopper resulted in poor ash collection and high ash loading to downstream equipment. Finally, high flue gas velocities and low

heat transfer surface area for the economizer and tubular air heater (TAH) contributed to high erosion, high flue gas outlet temperatures, and low boiler thermal efficiency. The high gas exit temperature also increased the flue gas volumetric flow, which limited the ID fan capacity.

To remedy these performance limitations, JANSEN and MP determined a path forward for boiler improvements that included a new OFA system, a redesigned GB outlet ash hopper, a larger economizer, a new TAH, and new biomass distributors.

Between 2010 and 2012, all but the new biomass distributors were installed on the No. 3 Boiler, and the new OFA system and redesigned GB outlet ash hopper were installed on the No. 4 Boiler. The economizer and TAH upgrades on the No. 4 Boiler are scheduled for 2014. Engineering for new biomass distributors has been initiated, but an installation date has yet to be determined.

Following the No. 3 Boiler upgrades, boiler efficiency has been increased by 6 percentage points and resulted in 10% increased steam generation for the same fuel firing rate. Biomass firing now accounts for ~78% of the fuel heat input. Adequate operating margin for the ID fan has also been realized. Finally, the installation of new biomass distributors will achieve the ultimate goal of eliminating coal firing altogether and generating 300,000 lb/hr of steam from biomass firing.

This paper illustrates an upgrade program, providing a road map for the various boiler operating parameters and auxiliaries that should be evaluated, and equipment to be installed to increase biomass firing in a stoker boiler.