2019 **Title:** **Multi-Fuel Boiler Combustion System Upgrade and Controls Optimization**

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ABSTRACT:

Wheelabrator Technologies Inc. (WTI) operates the Wheelabrator Ridge Energy Generating Station in Auburndale, Florida. The facility consists of a single 664.7 GJ/hr multi-fueled steam power boiler with air cooled traveling chain grate stoker supplied by Zurn Industries. Steam from the boiler is used to generate up to 50 MW of electrical power in a steam turbine/generator. During a typical day, the unit operates at a peak load steaming rate of 156.5 tons/hr for about 11 hours while firing a mixture of landfill gas, wood waste and municipal solid waste consisting of tires and yard waste. During six hours at night, the load on the unit is lowered to below 90.7 tons/hr while firing wood waste only. The remaining seven hours of the 24-hour period correspond to times of load and fuel mix transition.

The unit is subject to a carbon monoxide (CO) emission limit of 90.7 kg/hr on a 30-day rolling average equivalent to approximately 339 ppm (dry at 7% oxygen (O2)). This limit was considered a first ever Best Available Control Technologies (BACT) limit for this type of multi-fuel fired boiler. The boiler has been classified as a Refuse Derived Fuel (RDF) stoker boiler under the United States Environmental Protection Agency's (USEPA's) Large Municipal Waste Combustor (MWC) requirements in 40 CFR 60, Subparts Ea/Cb. With the classification as a RDF stoker boiler under Subparts Ea/Cb the boiler would become subject to a lower CO emission limit of 150 ppm (dry at 7% O2) on a 24-hour block average. Classification as a RDF stoker under USEPA's Large MWC requirements, even with the lower CO limit, was preferred to classification as an Energy Recovery Unit (ERU) under the USEPA's Commercial and Industrial Solid Waste Incineration (CISWI) Maximum Achievable Control Technology (MACT) Emission Guidelines (Subpart DDDD). Jansen Combustion and Boiler Technologies, Inc. (JANSEN) was initially contracted by WTI to assess the existing boiler combustion system and following this assessment received a contract to engineer/implement combustion improvements to meet the 150 ppm Subpart Ea limit.

Review of historical operation showed that the unit operated on a continuous basis well below the BACT CO limit of 90.7 kg/hr but below the 150 ppm Subpart Ea limit for less than 60% of the time. The review also showed that CO levels would elevate and become more variable during peak load periods. Boiler combustion analyses revealed that heat input rates were low enough to allow significantly lower CO emissions provided combustion conditions could be improved.

The boiler combustion assessment was initiated in 2016 by a site visit where operating data was collected and evaluated to develop a baseline of boiler operation. Current and new combustion system arrangements were then evaluated with Computational Fluid Dynamics (CFD) modeling. The modeling confirmed that the primary cause of high CO emissions performance at peak load was due to the inherent limitations of the original overfire air (OFA) system which limited penetration and mixing of the OFA in the furnace. The original OFA system consisted of multiple rows of small ports on the front and rear furnace walls. Modeling of the furnace with larger and fewer OFA nozzles placed on the side walls in an interlaced pattern was shown to significantly improve CO burnout.

Additionally, combustion air flow metering instrumentation was limited preventing boiler operation in cascade mode following boiler load. This was a challenge to operations as manual adjustments to air damper outputs would be required to adjust the air flows as the boiler went through its daily change in steaming rate and transitioning from firing a mix of landfill gas, wood waste, yard waste and chipped tires at peak load to wood waste only at low load.

In 2017, JANSEN began the combustion upgrade project which was to include installation of a new OFA system, updates to combustion air metering instrumentation and reconfiguration/optimization of the combustion controls. A minor air construction permit for installation of the new OFA system was obtained from the Florida Department of Environmental Protection (DEP) in August 2017. Installation of the new OFA system was completed in October 2017 during a major outage. Subsequent testing at the completion of the combustion upgrade project showed that CO was lowered by 50% from peak load levels and the unit could confidently achieve the 150 ppm 24-hour block average CO emission limit. In addition, the controls can automatically modulate the air flows to the various boiler operating loads to adjust to the daily changes in boiler load and the fuel mix between the landfill gas, wood waste and tires without requiring operator intervention.

This paper describes the process that led to a successful project, including: data collection and analyses, CFD modeling, equipment design and supply, controls reconfiguration, operator training, and start-up assistance.