REBUILDING THE RDF-FIRED STEAM GENERATORS AT METRO DADE COUNTY, FLORIDA

WILLIAM M. ZILL AND PHILIP J. MEEHAN
Zurn Industries, Inc.
Erie, Pennsylvania

ABSTRACT

The Energy Division of Zurn Industries, Inc. was contracted in December 1987 to demolish, redesign, and rebuild four (4) dedicated Refuse Derived Fuel (RDF) fired boilers at the Metro Dade County Resources Recovery Facility. The work included enlarging the furnace, replacing the stoker, and furnishing all new pressure components, airheater, and mechanical dust collector. Only the steam and mud drums were salvaged from the original equipment. The work also included features designed into the units to reduce boiler erosion, corrosion, fouling, and stoker maintenance problems that had chronically plagued the original units.

BACKGROUND

Operation of the Metro Dade County Resources Recovery Facility in Miami, Florida began in 1981. The facility processes municipal solid waste into RDF for combustion in four dedicated two-drum boiler RDF combustion units designed and supplied by others. The steam generated is used to generate 75 MW of electricity. Several problems occurred during the first few years of the facility's operation which eventually led to climbing maintenance costs and reduced operating efficiency. A change in operators was then made in 1985 with Montenay Power Corporation (MPC) awarded a new operating contract. With major equipment in need of repair, MPC and Dade County, Florida developed a comprehensive Capital Rehabilitation Program in 1987 to return the facility to the original permitted design capabilities [1]. MPC, in turn, contracted with Zurn for the boiler island portion of this rehabilitation program.

The boiler island consists of the stoker, furnace, evaporator, economizer, airheater, and mechanical dust collector. The original equipment was designed to generate 191,400 pph (86,819 kg/h) steam at 625 psig (43 kg/sq cm) and 721°F (382°C) at Maximum Continuous Rating (MCR). MPC, however, reported to Zurn that MCR conditions were never obtained and that the boilers were experiencing severe erosion, corrosion, and fouling problems. Other problems involving stoker repairs and rebuilds, tube and element replacement, and manual cleaning of the boilers, economizer and airheater were common events. MPC and Zurn determined that the facility's problems could be traced to:

(a) Insufficient furnace size.
(b) Too liberal of a grate heat release rate.
(c) Poor overfire air distribution.

These factors contributed to the overheating and fouling of the unit which necessitated constant equipment maintenance. The boiler island rehabilitation contract required Zurn to address these problems by redesigning and enhancing the boilers and stokers all within the facility's existing physical limitations.

ENGINEERING STUDY

Zurn's initial work was to conduct an engineering study of the existing equipment to determine the boiler and stoker needs for enhancing the operation of the units. The enhancements were to improve boiler availability and reliability, while working within the confines of the existing structural steel and other boiler ancillary equipment. After an extensive study, which included flow modeling the gases through the boiler, the following boiler island component modifications were recommended.

STOKER

Zurn would replace the existing stoker with a Zurn Travagrate spreader stoker. This new stoker, originally designed for wood, coal, and biomass in the 1950s, had been successfully employed at an RDF fired plant in Albany, New York since 1979. The Zurn stoker employs a full width supported catenary grate design and would be sized to the dimensions of approximately 19 ft wide by 23 ft long. A new concept added in the catenary area over the Zurn's Albany Mall Project was to incorporate a molten aluminum catch tray system. The RDF contains aluminum, which becomes molten and may seep down through the top surface of grate and land on the underside of the grates at the bottom of the catenary. This molten aluminum solidifies on the underside of the grates and causes pluggage, binding or locking of two or more grates. Unimpeded, deposition of molten aluminum onto the grate underside may freeze and lock the entire stoker, requiring a shut down and an extensive maintenance outage. The molten aluminum catch tray system captures molten aluminum on inclined trays, which are removable and cleaned as required. These trays have subsequently proven to be very effective in collecting molten aluminum and solving the grate lock-up problem.

What was once a weekly shutdown for a grate lock-up problem has been replaced with a monthly cleaning of the removable catch trays.

FURNACE

The width and depth of both the furnace and grate were confined to the original dimensions for the rebuild. The original grate and furnace volumetric heat release rates were considered to be excessive for firing RDF. These rates were reduced to Zurn's limits of 650,000 Btu/sq ft for the grate surface and 15,000 Btu/cu ft for the furnace volume. Reducing these rates was accomplished by adding seven more ft (2.13 m) to the original furnace height and downrating the stream capacity of the boiler from the original 191,400 pph (86,819 kg/h) to 180,000 pph (81,648 kg/h), yielding a more conservative furnace design. Flue gas residence time was also enhanced from 2.2 sec to 2.9 sec, which yielded a lower gas temperature into the superheater of 1600°F (871°C) in lieu of the original 1750°F (954°C). Physically raising the furnace and evaporator tube bank was accomplished by adding stub columns to the existing structural steel and redesigning the platforms to suit the new equipment elevations.

OVERFIRE AIR SYSTEM

Redesign of the overfire air system entailed much input from both MPC's past operating experience of the Dade Plant and Zurn's Albany Mall RDF boiler. It was determined that high static pressure overfire air penetration of at least 70–80% of the boiler's depth [2] and multiple levels of overfire air nozzles would be required. To further predict the operation of the overfire air redesign, Zurn designed and fabricated a one-fifth scale plexiglass flow model of the stoker, furnace, superheater, evaporator, and the evaporator gas outlet duct. This large scale model permitted the study of various overfire air design concepts on flue gas flow through the boiler system prior to actual equipment manufacture.

Approximately thirteen (13) flow tests were run and video taped using smoke to study the air and flue gas flows. Wood chips and sawdust were used to represent the solid fuel flow. The effects of the molten aluminum catch tray system were studied as well as the three (3) levels of overfire air nozzles with their two (2) different designs (in-line opposed and staggered). One (1) additional test was run and video taped at the request of the customer, after the newly rebuilt units were operating, to study the effects of a new operating condition.

FURNACE OUTLET

The design of the furnace outlet area included an upper furnace bull nose to turn the flue gases directly into the furnace exit screen and pendant superheater. Tube spacing in the superheater was set to ensure conservative gas flow velocities of under 20 ft/sec (6 m/sec). The steam and mud drums were the only pressure part components reused from the original equipment, but contained tube hole spacing drilled to metric dimensions. In order to make the transition, three (3) intermediate headers, two (2) in the rear wall and one (1) in the roof, were used to convert the standard U.S. waterwall spacing to the metric drum spacing.

ECONOMIZER, AIRHEATER, AND DUST COLLECTOR

The original boilers were each furnished with one (1) bare tube economizer located directly above the boiler gas outlet opening. These economizers were undersized for the duty required leading to inadequate heat recovery, loss of efficiency, and elevated flue gas temperatures being passed along to the downstream equipment.

The bare tube economizers were redesigned into two (2) shop assembled modules complete with all new headers, retractable soot blowers, insulation and lagging.

Each boiler was also furnished with one (1) tubular airheater located downstream of the economizer. The original airheaters were plagued with erosion and fouling problems due to the original design using 2-in. (50.8 mm) O.D. tubes × 20-ft (6096 mm) long. The tubes were found to be too small in diameter and too long in length for this type of dirty RDF fired service and were redesigned using 2½-in. (63.5 mm) O.D. tubing × 11-ft 3-in. (3429 mm) long to reduce fouling of the tubes. Ceramic tube ferrules and refractory protection at the hot gas inlet end of the airheater were also provided to reduce hot end erosion. The new airheaters were shop assembled and tubed on site after erecting the airheater frame in place.

Included with each airheater was a cold air bypass duct to provide an additional means of controlling furnace temperatures by reducing the undergrate air temperature.

A mechanical dust collector was furnished complete with hoppers and designed for 75% collection efficiency. This dust collector was installed to relieve the particulate loading on the existing electrostatic precipitators.

APPURTENANCES

All of the existing walkways, ladders, and platforms were reused or relocated as much as possible. The revised location for the drum access doors, observation ports, and new soot blowers were provided with new access platforms.

All new trim for the boilers, superheaters, and economizers, except for factory rebuilding of the superheater electromatic relief valves and boiler nonreturn valves, were also furnished as part of the redesign.

A side view of the final boiler design is shown in Fig. 1 with the design conditions shown in Table 1.

TABLE 1 DESIGN CONDITIONS OF THE DADE COUNTY RESOURCES RECOVERY (Miami, Florida)

Capacity:	180,000 lbs/hr (81,648 kg/hr)
Design Pressure:	732 PSIG (51 kg/sq. cm.)
Operating Pressure:	625 PSIG (43 kg/sq. cm.)
Steam Temperature:	721 Deg. F. (383 Deg. C.)
Feedwater Temperature:	350 Deg. F. (177 Deg. C.)
Fuel:	Refuse Derived Fuel
Gas Temperature Entering Superheater:	1600 Deg. F. (871 Deg. C.)
Gas Temperature Leaving Boiler:	795 Deg. F. (424 Dec. C.)
Gas Temperature Leaving Economizer:	613 Deg. F. (323 Deg. C.)
Gas Temperature Leaving Airheater:	482 Deg. F. (250 Deg. C.)

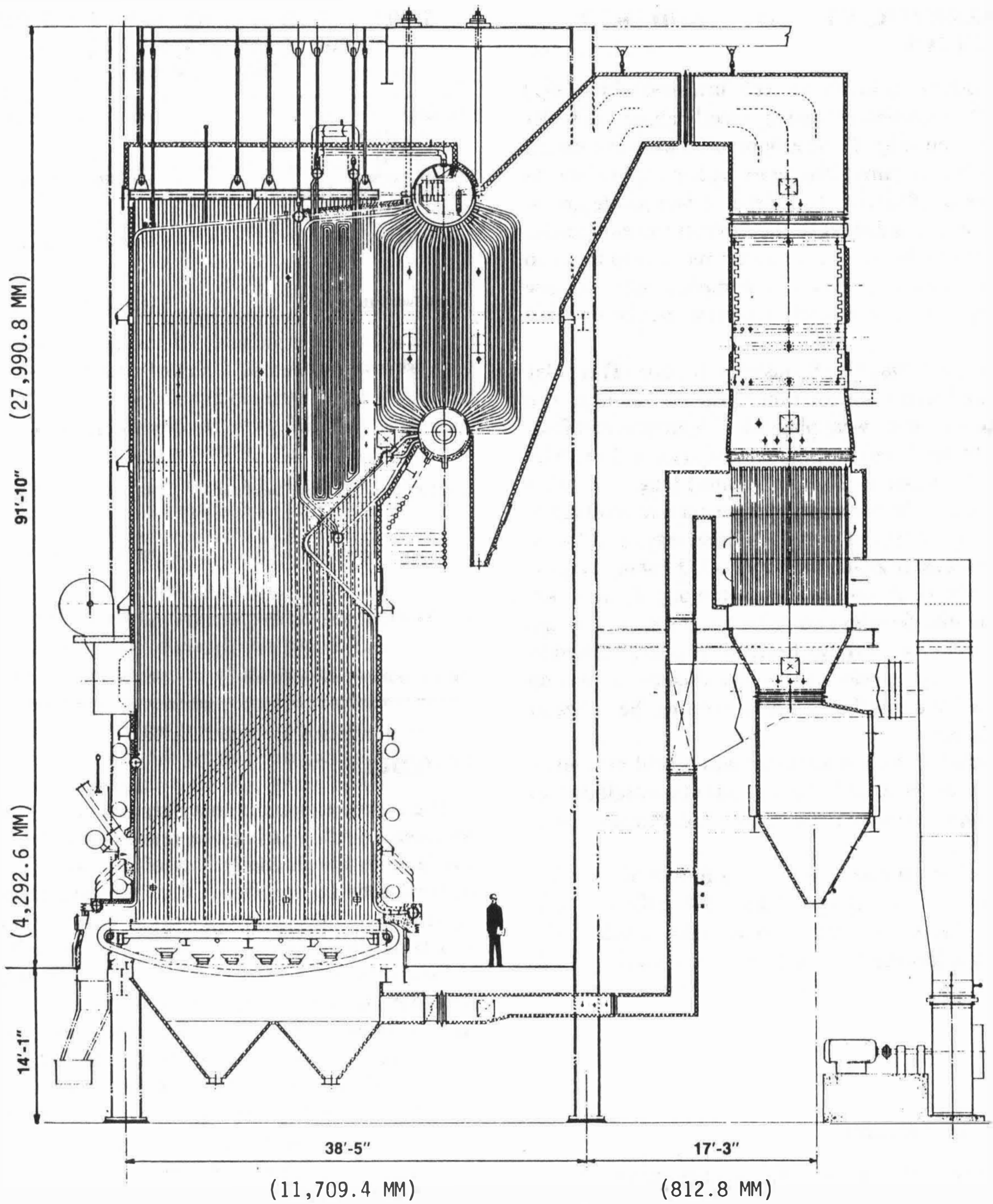
SCHEDULE

The contract required that only one boiler at a time be rebuilt while leaving the remaining three boilers available to fire the daily flow of incoming fuel. The original contract specified a total schedule of twenty-eight (28) months from the start of demolition of the first boiler to the initial start-up of the fourth boiler.

Commencing in December, 1987, the first unit was demolished, rebuilt, and put back on line eight (8) months later in July, 1988. The remaining three (3) boilers were likewise demolished, rebuilt, and put back on line in the following eighteen (18) months. The total scheduled time required twenty-six (26) months to complete and represented a two (2) month improvement over the original schedule.

PERFORMANCE GUARANTEES AND TEST RESULTS

Zurn guaranteed a fuel firing rate of 28.0 tons/hr (25,400 kg/h) based on firing 5000 Btu/lb RDF (2455 kcal/kg) with a moisture content of 38.8% and an ash content of 9.0%. At this firing rate, steam production is guaranteed at 180,000 pph (81,648 kg/h) with a guaranteed maximum flue gas temperature to the



Rating .... 180,000 lbs/hr (675 tpd)
Fuel .... Refuse Derived Fuel
Design Pressure .... 732 PSIG
Steam Temperature .... 721 Deg. F.

FIG. 1 DADE COUNTY RESOURCES RECOVERY
(Miami, Florida)

superheater of 1600°F (871°C). Steam purity is also guaranteed at 1.0 ppm.

Performance tests were conducted in May, 1989 and the above listed MCR conditions were met on all four (4) boilers. CO and NO_x emissions were also tested and reported to be within permitted EPA levels.

CONCLUSION

This project demonstrated the feasibility of singularly redesigning and rehabilitating four (4) RDF units while permitting a continuous firing of RDF fuel in the remaining units. The possibility of rehabilitating similar units may be warranted provided detailed engineering studies can determine in advance the required improvements to be made in the boiler design. Changes made to the design of Dade's original equipment such as the multi-level overfire air system, increased furnace volume, derated steam output, and a molten aluminum catch tray system have successfully increased the reliability and availability of the Dade County Facility.

REFERENCES

[1] Strong, Charles R. "Metro Dade County Resource Recovery RDF Facility: Past, Present, and Future," *Energy Progress*, **8**, *4*, December 1988, 189–190.

[2] Dvirka, Miro. "Resource Recovery: Mass Burn Energy and Materials," in *The Solid Waste Handbook, A Practical Guide*, Chapter 13, 1986, pp. 557–593.