

# PERFORMANCE OF THE RDF DELIVERY AND BOILER FEED SYSTEM AT THE LAWRENCE, MASSACHUSETTS FACILITY

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## ABSTRACT

Historically the systems to store, retrieve from storage, deliver and feed refuse derived fuel (RDF) to a boiler furnace have been troubled with problems of reliability, high maintenance costs and non-uniform feeding. Erratic feeding of the boiler causes poor load following capability, efficiency losses, tube corrosion, and potential emission problems among others. This paper will describe a unique combination of floor storage, fuel delivery and boiler furnace feed system that has been operating reliably at the Lawrence, Massachusetts facility since the fall of 1984. The system which feeds a new 250,000 lb/hr (113,379 kg/h) Babcock and Wilcox boiler designed for and fired by 100% RDF, has not encountered problems with blockages, high wear or erratic flow.

## HISTORY

A variety of RDF storage, retrieval and boiler furnace feed systems have been used in the last 10 years. Certain features of each system have limited its usefulness and acceptance. Examples of previously used systems and their shortcomings are:

## PNEUMATIC SYSTEMS

Pneumatic feed systems are limited by the following:

- (a) plugging of pneumatic lines due to oversize pieces of RDF
- (b) high wear in pneumatic lines due to high transport velocities with relatively abrasive RDF
- (c) cost and space required for redundant storage/retrieval equipment is prohibitive
- (d) inability to uniformly cover the traveling grate makes system unacceptable for a 100% RDF fired boiler

## METERING BINS

Metering bins with horizontal and vertical augers are limited by the following:

- (a) textiles and wire wrap around small diameter augers making them ineffective in transporting RDF; feed to furnace tends to be intermittent
- (b) high depth of material above augers, if achievable, increase auger wear and power consumption
- (c) access for repair is difficult and time consuming if equipment fails under a deep pile of RDF
- (d) cost and space required for redundant storage/retrieval equipment is prohibitive

(e) uniform depth of fuel on the grate may be difficult to achieve, depending on means of distributing RDF from the single outlet on the metering bin to several boiler air swept feed chutes

## DRAG CONVEYORS

Drag conveyor style distribution system utilizing staggered openings in the drag conveyor pan connected to air swept chutes is limited by the following:

- (a) high wear of drag conveyor system
- (b) cannot quickly or automatically vary the split of RDF between chutes and therefore bias certain areas of the furnace to achieve optimum combustion
- (c) pieces of tramp metal can break drag flights, causing occasional damage and downtime
- (d) drag conveyor chains run directly in RDF resulting in stringy items becoming entangled in chain and sprockets causing occasional downtime

## DESIRABLE FEATURES

Analysis of existing concepts of storage, delivery and boiler feeding and their deficiencies points out the need for a system with desirable performance features as follows:

- (a) reliability—must work 24 hr/day, 7 days/week
- (b) 100% redundancy if possible (from space and cost viewpoint)
- (c) variable speed feeders close to boiler for quick response time
- (d) smooth continuous flow of RDF to the boiler, spread uniformly over the traveling grate
- (e) enough feeders and air swept chutes into the furnace to continue at or near full load if one or two feeders malfunction
- (f) system that delivers fuel to the boiler with consistent bulk density—not fluff one minute and chunks the next minute
- (g) low maintenance cost and low power consumption
- (h) easily accessible—critical machinery not covered by tons of RDF
- (i) physically rugged to handle occasional pieces of wood, textiles, tramp metal or similar troublesome items.

## THE HAVERHILL FUEL PREPARATION FACILITY

To properly evaluate performance of the storage, retrieval and boiler feed system, physical characteristics of the fuel and means of preparation must be known. The fuel preparation facility (Fig. 1) located in Haverhill, Massachusetts is owned and operated by Refuse Fuels, Inc. Thirteen hundred TPD (1,179,138 kg/day) are processed into 983 TPD (891,610 kg/day) fuel, 57 TPD (51,701 kg/day) ferrous and 260 TPD (235,828 kg/day) glassy residue. Two redundant Heil 70 TPH (63,492 kg/h) processing lines (Fig. 1) shred a mixture of residential, commercial and industrial waste to a particle size of 90% less than 4 in. (101.6 mm). Ferrous is removed by Dings solid waste magnets and head pulley magnets. Shredded refuse is passed through a two stage 12.5 ft (3.8 m) diameter  $\times$  60 ft (18.24 m) long trommel screen. The glassy residue from the first half of the trommel with 1 in. (25.4 mm) diameter holes is landfilled. The RDF, a combination of material from the second half of the trommel with 6 in. (152.4 mm) diameter holes and shredded trommel oversize is conveyed into the fuel storage building and stacked with a front end loader. RDF characteristics on an "as received" moisture basis are 6000+ Btu/lb (13.96 MJ/kg), less than 15% ash, and particle sizes of 97%, by weight, less than 4 in. (101.6 mm), 88% less than 3 in. (76.2 mm) and 72% less than 2 in. (50.8 mm).

RDF is removed from storage with a front end loader and placed into open top trailers for delivery to Lawrence, Massachusetts, located approximately 5 miles from Haverhill. The Babcock and Wilcox boiler at Lawrence produces 250,000 lb/hr (113,379 kg/h) at 650 psi (4481 kPa) and 750°F (399°C). The boiler, fired by RDF only, provides steam for electricity generation and other commercial/industrial uses.

## LAWRENCE STORAGE/RETRIEVAL AND FEED SYSTEMS

The Lawrence facility (Fig. 2) contains two completely redundant fuel delivery systems coupled with six Detroit metering feeders which individually feed RDF to six Detroit air swept spouts located in the furnace front wall.

At the receiving facility, each trailer ejects 15–20 tons (13,605–18,141 kg) of RDF on the floor in close proximity to each of two horizontal feed conveyors located 4 ft (1.22 m) below floor level. A rubber tired front end loader moves RDF from the storage pile into

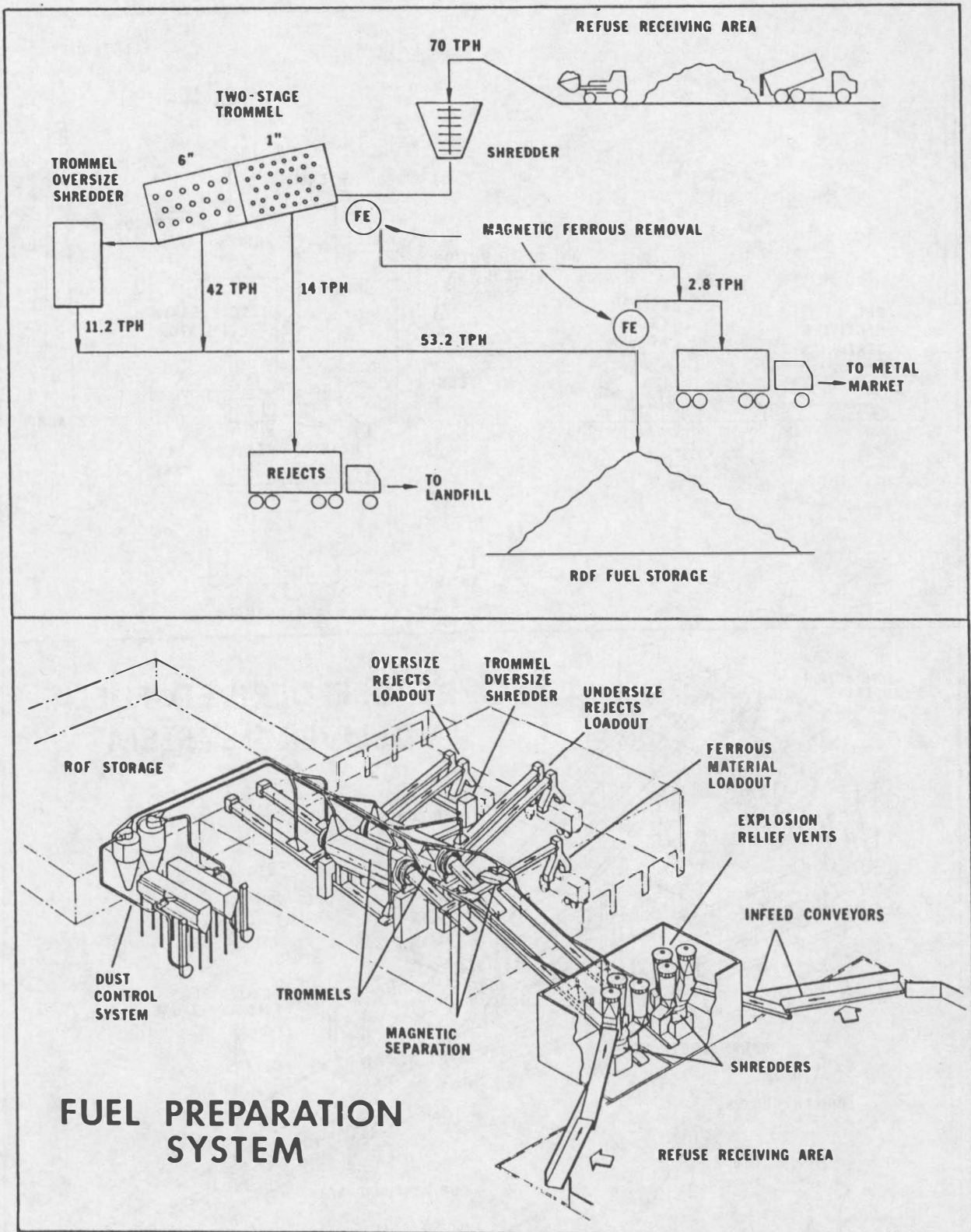


FIGURE 1

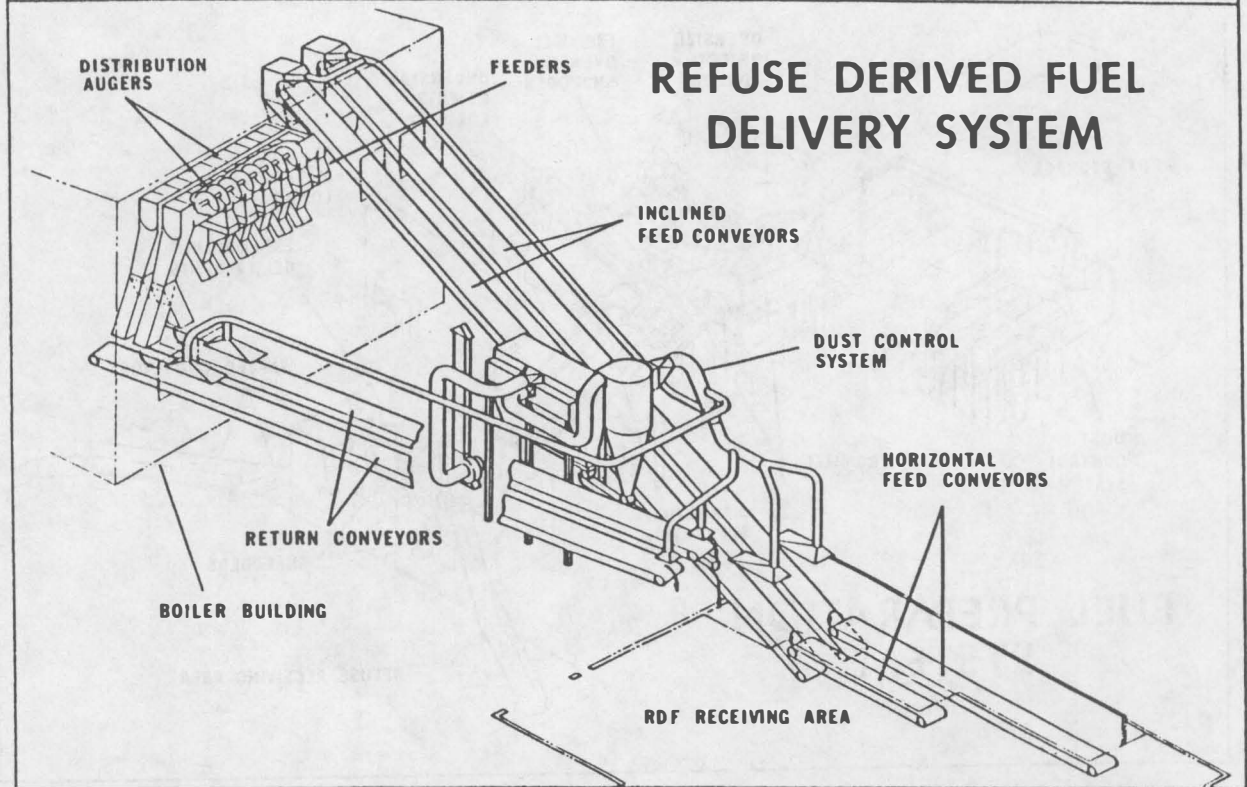
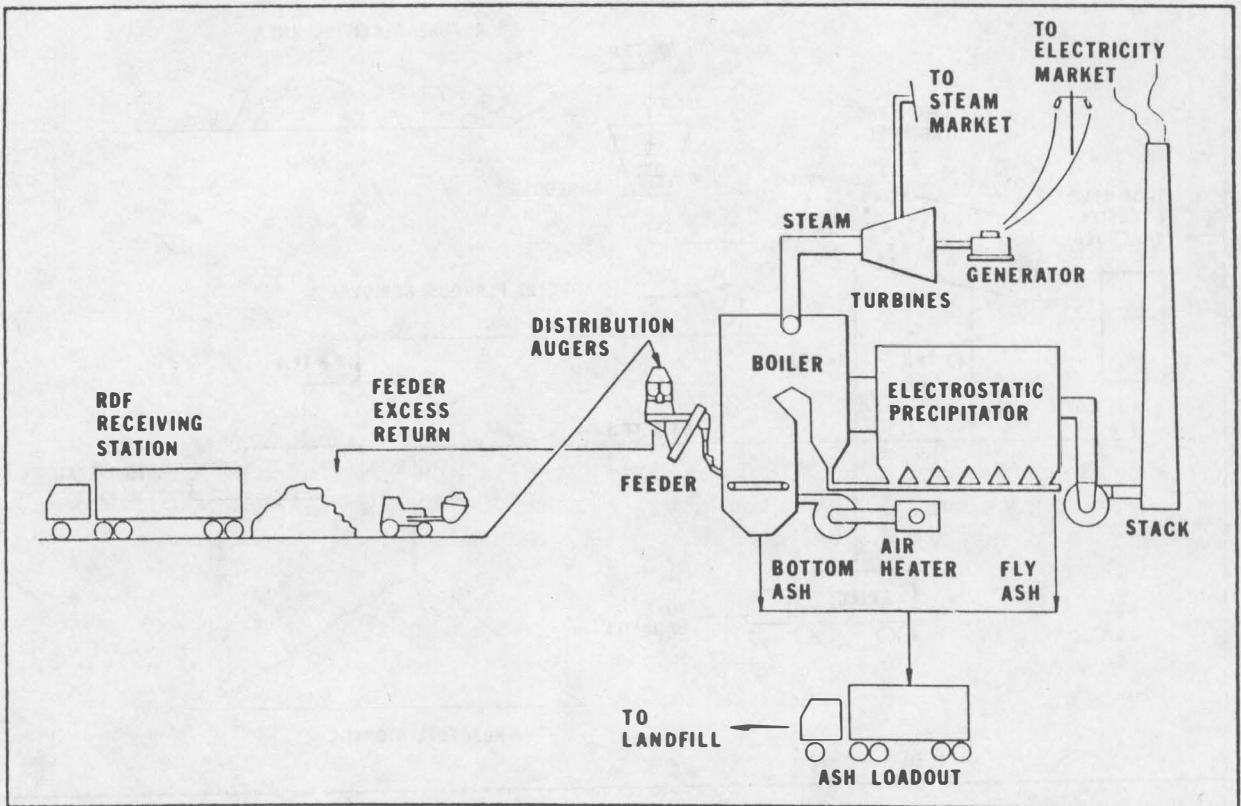


FIGURE 2

a 54 in. (1.3 m) wide horizontal conveyor at a rate slightly exceeding the boiler requirements. The RDF transfers to a 60 in. (1.52 m) wide inclined conveyor leading into the boiler building. Each inclined conveyor has the option of feeding, via swing chutes, one of two Heil distribution augers mounted over the top of the six Detroit feeders. A slide gate at each auger trough opening can isolate each feeder for maintenance purposes if necessary. Each feeder contains a surge hopper and a lower RDF hopper. The surge hopper is kept full at all times with either of the over-running distribution augers. All sides of the surge hopper are negatively sloped to eliminate bridging. The surge Hopper bottom consists of a hydraulically operated ram which can be retracted or extended to move RDF from the surge hopper to the lower RDF hopper. The lower RDF hopper incorporates a steeply inclined hinged steel belted conveyor and three discreet level detectors located within the hopper side. These level detectors signal the hydraulic ram to "run" or "dwell" to ensure RDF is kept at an optimum level in the lower RDF hopper. The inclined hinged, steel belted conveyor is driven by a variable speed D.C. motor controlled by the boiler control signal. The RDF hopper and conveyor flight design, combined with the steep incline of the conveyor, causes a mixing and fluffing action within the hopper, resulting in uniform conveyor feeding to each air swept chute. Precise metering and consistent densities are achieved with minimal bridging or compaction. This feed system provides uniform distribution of fuel over the moving grate, resulting in controlled combustion.

Excess RDF at the end of each distribution auger is diverted to either of the two troughed rubber belts returning to the receiving building. The excess RDF is dumped on the floor adjacent to the horizontal feed conveyors and is combined with additional RDF being fed into the system.

## SYSTEM PERFORMANCE

The storage, retrieval, delivery feed system has performed well since start-up in August, 1984. There have been minimal boiler shutdowns, operation at reduced load or any other intermittent or undesirable occurrences due to the feed system. Specific facility design and operating characteristics, short comings and recommended improvements are as follows:

(a) The receiving building at the Lawrence facility is smaller than desirable due to space limitations within an existing industrial area. Floor storage of RDF has proven to be a simple and relatively inexpensive means

of storing fuel for nights and weekends. Its capacity is limited only by building size. First in-first out handling can be accommodated easily.

(b) The use of a front end loader to retrieve from storage and feed the boiler is simple, reliable and inexpensive. Another loader can be obtained quickly if the first one breaks down. This method requires one loader operator per shift, 7 days/week. Due to the limitations of the other types of storage, retrieval and feed systems described earlier, a full time operator may also be required to monitor the operation of these more costly automated systems. The front loader operator never needs to be concerned about boiler load fluctuations. As long as there is a slight amount of RDF being discharged by the return conveyors (approximately 10% of input), he knows the feeders are full and can vary his input accordingly.

(c) The horizontal feed, inclined feed and excess return conveyors have been a reliable means of transporting material. In this application and climate, however, special attention must be given to the following:

(1) The 30 deg. inclined rubber belt conveyors, between storage and boiler buildings, although skirted and covered, are exposed to ambient temperatures. In winter, at temperatures approaching zero, the belt is cold enough to partially freeze the RDF in contact with its surface. This has caused intermittent slippage of RDF on the inclined belt conveyor. This situation can be avoided by extensive use of cleats or shallow conveyor angles (less than 18 deg.) or other means to assure belt temperature is above 15°F (-9°C).

(2) Conveyors must be skirted, covered and otherwise sealed to prevent fugitive dust emission. Although the Lawrence system is fully sealed and incorporates a network of dust collection pickups at conveyor transfer points, additional hoods, ducting and a higher capacity dust collection system should be employed on future systems. Boiler buildings usually operate under negative pressure due to the action of several fans within the building. Draft at boiler building penetration points requires special attention to conveyor enclosures and dust control measures. Dust control should be incorporated in the area where RDF is fed into the conveyor system by the front end loader.

(d) One of the key pieces of equipment is the 4 ft (1.22 m) diameter distribution auger over the Detroit feeders. The auger core tube was designed at 2 ft (0.61 m) in diameter equating to over 6 ft (1.83 m) in circumference to discourage long pieces of textiles or wire from permanently wrapping around the auger. The auger is stopped once a day to remove a slight amount of wrapping at the auger discharge end. The adjacent auger is placed into service during this ½ hr cleaning

time. Three-quarter in. (19.1 mm) thick flights with replaceable liners are welded to the central tube; the auger spans 46 ft (14.0 m) without any intermediate hanger bearings which have historically caused jam points. The distribution auger contains only one moving part thereby reducing the potential of failure. The size and speed of the auger allows 50 TPH (45,351 kg/h) of RDF to be distributed to the feeders with less than 30% fillage of the auger trough. The auger is therefore not submerged in RDF and does not encounter extensive wrapping, high wear and high power consumption. The auger is immediately accessible and not buried under tons of RDF if a mechanical problem should occur.

Some stratification of fuel density has been observed between the first and last feeders. More suspension firing and some slagging occurs at the furnace wall

near the last feeder. This phenomenon and its potential effects on the boiler is currently being investigated.

## SUMMARY

The overall system at Lawrence performs well. The ability of the variable speed feeders to follow boiler steam demand has been excellent. Knowledgeable operators have favorably compared the boiler responsiveness to one fired with natural gas. Availability of the entire system has exceeded 98%. Preventative maintenance costs have been low. Minor refinements should result in very reliable well accepted systems on future installations.

**Key Words:** Boiler; Combustion; Materials Handling; Performance; Refuse Derived Fuel