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**OPTIMIZING SYSTEM PERFORMANCE AND REVENUE FROM
METALS RECOVERY SYSTEMS AT
WASTE-TO-ENERGY FACILITIES**

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ABSTRACT

This paper will review several new Metals Recovery Systems (MRSs) that have been added to existing Waste-to-Energy (WTE) facilities over the past few years. Beginning with the discussion of a basic process flow diagram (PFD), recent equipment refinements, which improve the quality of both ferrous and non-ferrous metals, will be explained. The paper will then present ranges of typical metals recovery from the WTE plants. A historical review of the fluctuations in the metals market, and the implications for major capital investments for a MRS, will be discussed, and a project schedule will highlight all key components of a MRS project.

INTRODUCTION

This paper is a follow-up to an earlier review of MRS additions at three WTE facilities, which was published in May 2008 (NAWTEC 16). In early 2008, these three referenced

MRS facilities were either in construction or being designed. In 2010, all three installations are in full-scale operation. As shown in Figure 1, non-ferrous metals (NFM) pricing had been steadily rising from 2001 through 2007. The revenues from recycling both ferrous (Fe) metal and NFM made the financial decision to expend significant capital monies on process equipment and building additions, to extract these metals from combustion ash, a simple effort. However, the global financial downturn in late 2008 and early 2009 resulted in a significant decline in the value of these metals, and a decision to proceed with a new MRS project became economically problematic. Fortunately, in late 2009 and early 2010, the metals recycling market has rebounded and the implementation of MRS projects in the U.S. will likely continue.

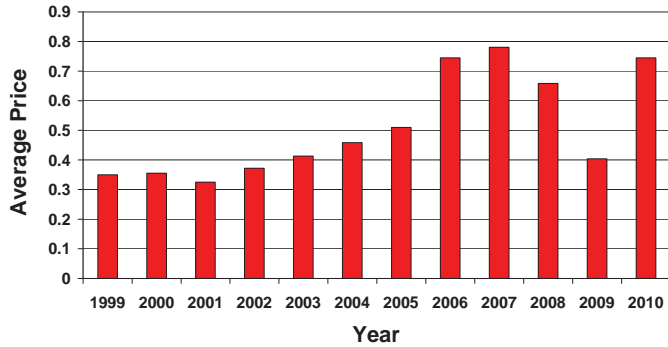


Figure 1. NFM Pricing

In addition to a MRS providing increased revenue to a WTE facility, another significant financial benefit is produced by the reduction in the quantity of material going to landfill. In each ash landfill, “air space” has a value that financial analysts are able to define. Thus, each cubic yard of “air space” results in a cost avoidance by the facility or municipality based on the metals diversion to recycling.

This paper will review a typical MRS design, metal pricing trends, metals yield from the three referenced facilities, sample metals revenue and capital cost payback, as well as a project implementation schedule.

EXISTING FACILITIES WITH METALS RECOVERY

Table 1 lists the three referenced facilities, nameplate MSW throughput, type of ash that may go through the MRS, and the recovered metal streams. All three facilities are now in full-scale operation. Facility A required substantial buildings, Facility B needed some minor interior pushwall additions for non-ferrous metal storage, and Facility C only required non-ferrous process equipment which fit inside the existing Ash Management Building.

Facility	MSW Throughput	Ash Types	Recovered Metals
A	2250 tpd	BA	Fe, NF
B	1500tpd	BA	Fe, NF
C	1000 tpd	CA	Fe, NF

Table 1. WTE Facilities

Table 2 indicates the recent yields of ferrous and non-ferrous metals from the three referenced facilities. These percentages are based on the tons of MSW processed.

Metals Yields (% of MSW)			
Metal Type	Minimum	Average	Maximum
Ferrous	2.25	2.53	2.83
Non-Ferrous	0.06	0.08	0.11

Table 2. Metals Yields

PROCESS FLOW DIAGRAM (PFD) FOR A MRS

A typical PFD for a MRS is shown in Figure 2. In this system, only bottom ash (BA) is processed for metals removal. Fly ash (FA) is transported via conveyors, conditioned with water, and added to the BA, to become combined ash (CA) prior to truck loading.

As shown in Figure 2, the main equipment components of a MRS are:

1. Finger Deck Screen
2. Drum Magnet
3. Feeder/Screenner
4. Eddy Current Separator (ECS)

The finger deck screen (1) (typically nominal five inches to six inches sizing) scalps off large Fe items (e.g. tire rims, piping, propane tanks, etc.). This scalped material is usually described as “bulkies”. Although “bulkies” are discharged to the Fe bunker, the large non-Fe items contain Fe contaminants (concrete, bricks, tree limbs, etc.) which, in most facilities, are removed by a crane electromagnet prior to shipment to the Fe recycler.

A Fe Drum Magnet (2) (typically an electromagnet) removes the Fe material from the BA stream (after scalping). The Fe product is then conveyed to a bunker with 15 to 20 feet high concrete push walls, to allow for three to four days of material storage. In some cases, this Fe material is stored with the “bulkies”.

The BA stream is now ready for NFM recovery. However, the next step is removal of small BA particulates (having a minimal quantity of NFM), by utilizing a feeder/screener (3). This piece of vibrating equipment drops out the fine BA through screen mesh, with openings of approximately 3/8 inch x 1 inch. Now, the +3/8 inch, -6 inch BA is ready for NFM recovery.

The ECS (4), using rotating rare earth magnets at the head end of the ECS belt conveyor, creates the eddy currents, which causes NFM to be “ejected” beyond the falling BA. It is collected in either a bin or small bunker, for transportation to a NFM recycler.

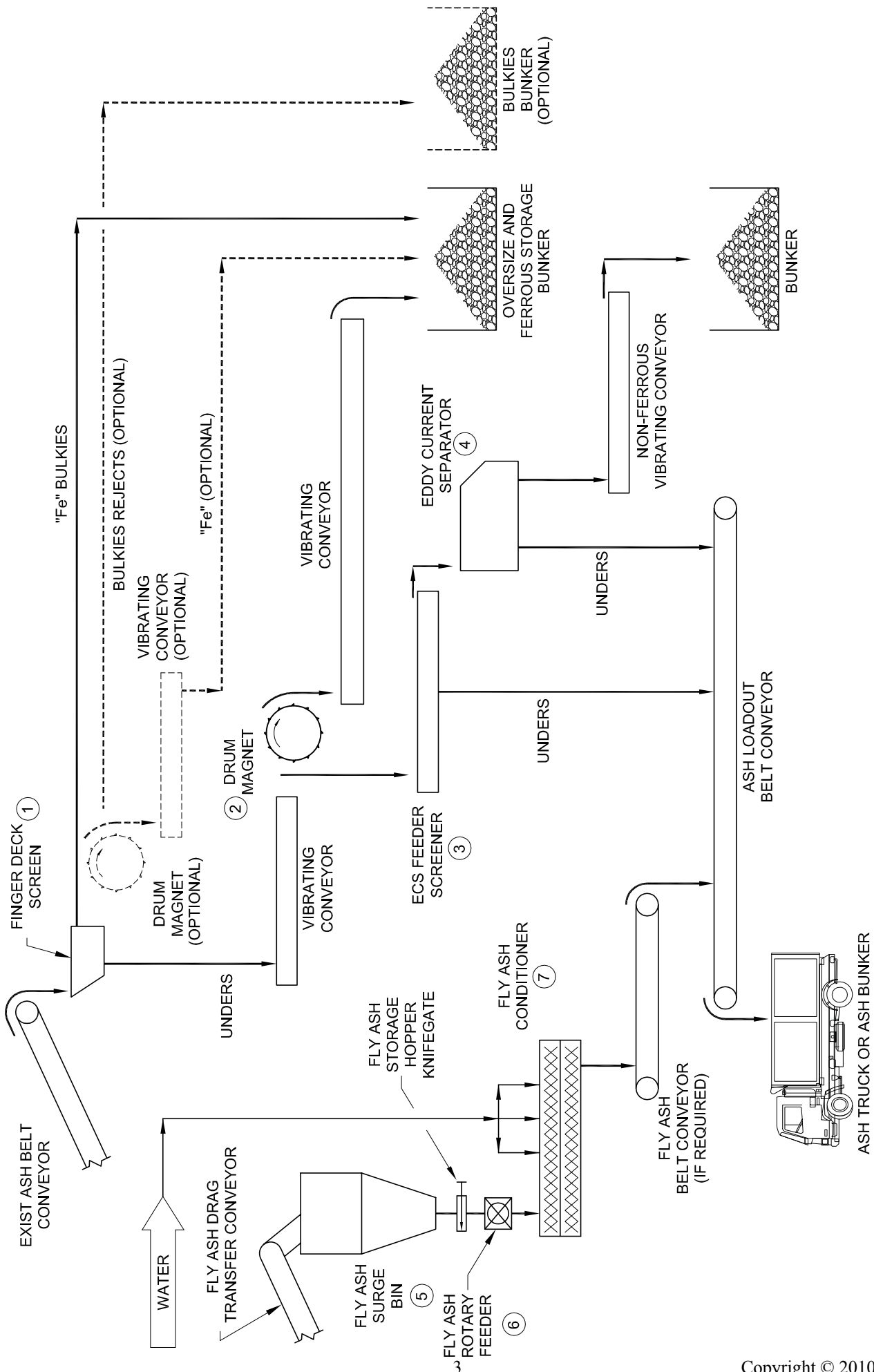


FIGURE 2 FLOW DIAGRAM

The typical equipment components for the FA bypass systems are:

5. FA Surge Bin
6. Rotary Feeder / Screw Conveyor
7. FA Conditioner

Drag conveyors are normally used to convey FA to a FA surge bin (5) typically with two to three hours of storage. As the FA feed rate is not uniform, the FA surge bin allows for a more uniform discharge rate (either low or high exit flow via a rotary feeder).

The rotary feeder /screw conveyor (6) is a typical method to withdraw FA from the surge bin and discharge to the FA conditioner.

The FA conditioner (7) or pugmill, has twin shafts and paddles which push the FA through the unit, and spray nozzles which provide water to the FA for dust control. After the FA is “conditioned”, it is dropped onto the BA conveyor just prior to truck loading.

SAMPLE CALCULATION

Assume a 2,000 tpd WTE facility at 95% availability, Fe at 2.5% of MSW throughput and NFM at 0.10% of MSW throughput, Fe income at \$60/ton and NFM income at \$0.70/pound. Total capital cost for engineering, permitting, equipment purchase and construction equals \$5 million. Calculate the simple payback:

Annual MSW throughput = 693,500 tons

Annual Fe Metal Revenue:

$$693,500 \times .025 \times \$60 = \$1,040,250$$

Annual NFM Revenue:

$$693,500 \times 2,000 \times .001 \times \$0.70 = \underline{970,900}$$

Total Metals Revenue: \$2,011,150

$$\text{Simple Payback} = \frac{\$5,000,000}{\$2,011,150} = 2.49 \text{ Years}$$

The above calculation does not take into account the relatively minimal O&M costs associated with a metals extraction system. However, it is clear that the Return on Investment (ROI) with improved metals pricing in 2010 and beyond makes a company’s decision to proceed with major capital expenditure for a MRS very attractive.

PROJECT IMPLEMENTATION SCHEDULE

As shown in Figure 3, a minimum of one year should be allowed from the start of a MRS project feasibility study through system start. Adequate time must be allowed for obtaining site plan reviews and environmental and building permits and the duration of these efforts could vary significantly from site to site. Tasks show in Figure 3 are discussed below:

TASK	1	2	3	4	5	6	7	8	9	10	11	12
Conceptual and Detail Design	█	█	█	█	█							
Permitting		█	█	█	█	█	█	█	█			
Equipment Procurement			█	█	█	█	█					
Bidding/Selection of General Contractor					█	█	█					
Construction								█	█	█	█	█
Start-up												█

Figure 3. Implementation Schedule

Conceptual and Detailed Design

The duration for these two tasks is estimated at five months. Conceptual building and equipment layouts and material flow diagrams are developed by the design engineer and reviewed with the plant staff. Special consideration must be given for handling ash during various phases of construction. Completion of detailed design is necessary to apply for a local Building Permit and to obtain bids for the General Contractor.

Permitting

This effort may have two steps: filings for a solid waste permit modification and, later for the building permit. Typically, environmental permitting requires basic layout drawings, whereas building permit review requires final detailed documents. This effort should take about eight months, but could vary significantly depending on local state code requirements.

Equipment Procurement

The process equipment for a MRS is typically purchased by the facility purchasing agent using specifications developed by the design engineer. The delivery of all process equipment should be completed prior to or early in the construction process to ensure that the General Contractor is able to set equipment in place per the erection schedule. Figure 3 indicates that the equipment is at the site by the end of month seven. This coincides with the selection of the General Contractor and commencement of construction.

Bid/Select the General Contractor

The General Contractor is responsible for construction of all building additions (including concrete walls and slabs, structural steel, siding and mechanical ventilation), setting process equipment and chutes, and all electrical and control

work. Typically, a Request for Proposal (RFP) will be issued to several bidders in month five and the selected General Contractor will be under contract by the end of month seven.

Construction Phase

Figure 3 indicates the construction phase duration of four and one-half months. This is typical for larger MRS additions where building expansions (as at Facilities A and B) are required. However, at Facility C, all new process equipment fit inside the existing building and the duration of that General Contractor's work was only two months.

MRS Facility Start-up

As the construction phase moves toward completion, equipment vendors should have their field representatives at the site for a final equipment checkout. The combination of the facility staff, General Contractor and equipment supplier field representatives then work together to get the entire system functioning. For a well designed and constructed MRS, the start-up should require two weeks.

OPTIMIZING SYSTEM PERFORMANCE AND REVENUE

There are a great number of techniques that can be utilized to improve the MRS operation and produce additional metals revenues. Several of these are listed below:

- **Equipment Redundancy** --- The MRS must be designed so that if any equipment in the MRS is down, there will be no impact on the boiler operation, that is, bottom ash and fly ash can still be processed for landfill. System bypasses or redundancies will be required to accomplish this. Sometimes a bypass will allow ferrous metal recovery but not non-ferrous metal recovery. Fly ash conditioning must be considered when the system is operating in the bypass mode.
- **Produce Clean Metal Products** --- As shown in Figure 3, a "bulkies" permanent drum magnet can be added to have the scalped "overs" separate the ferrous material from the inert material. For the non-ferrous material, bunker washdown reduces contamination and rerunning the material through the MRS will also produce a cleaner product.
- **Maintenance** --- The MRS should be properly maintained to be operational as much as possible. Generally, when the system is down one or both of the metals are not recovered and are lost to the landfill, unless the ash is recycled back through the MRS.

SUMMARY

The recent increase in the value of recovered metals from ash at a WTE facility in late 2009 and early 2010 should renew

interest in expending capital for new MRS additions. Removing metals from the ash increases plant revenues and recycling rates while reducing the quantity of material going to the landfill.

REFERENCE

White, T. M., "Adding Metals Recovery Systems (MRS) to Existing Waste-to-Energy Facilities", published in NAWTEC 16 proceedings, May 19-21, 2008, Philadelphia, Pennsylvania.