PROBLEMS AND RESEARCH NEEDS IN RAW REFUSE SEPARATION

BASED ON

ACTUAL OPERATING EXPERIENCES

by

Stuart H. Russell

Henningson, Durham & Richardson, Inc.
Omaha, Nebraska

Introduction

The purpose of this paper is to describe the Ames Solid Waste Recovery System, discuss the research currently being conducted on the system, and finally suggest areas for further research based on experience during the system's first year of operation.

The System

The Ames Solid Waste Recovery System is a municipally owned and operated resource recovery system which separates municipal solid waste to recover ferrous and nonferrous metals, wood chips, baled paper, a silica aggregate, and a shredded, classified fuel which is fired as a supplemental fuel to produce electricity. Ames, (population 40,000) is located in Story County (population 65,000), in Central Iowa. The solid waste recovery system consists of three major components; the processing plant, the refuse derived fuel (RDF) storage and retrieval system, and the power plant. (See Figure 1)

The Processing Plant

The plant accepts all general household and commercial wastes including such items as white goods, tires, trees, furniture and other bulky wastes. Items not acceptable are demolition materials, automobiles, liquids, and contaminated and hazardous wastes. The process schematic is shown in Figure 2. Both private and commercial haulers can deposit waste at the plant. The large packer-type collection vehicles are automatically weighed as they enter, then are allowed to deposit their load on the tipping floor. A control charge is levied on each truckload of material brought in.

The waste is pushed onto the infeed conveyor by a frontend loader. It is then automatically processed through two stages of shredding, magnetic separation of ferrous metals, air density separation, and non-ferrous and aluminum separation. The system also includes a paper baling facility which bales source-separated newsprint and corrugated cardboard.

The RDF Storage and Retrieval System

The light combustible fraction of the waste stream separated by the air density separator is conveyed pneumatically underground to the storage area about 600 feet away. The storage bin is a conical type, 84 feet (25.6 meters) in diameter with a storage capacity of 500 short tons (454 metric tons).

The RDF enters the bin through a cylcone separator and falls into a conical pile. It is reclaimed by a system of bucket sweeps which cut the perimeter of the pile and drop it down through grates in the floor to four separate drag conveyor lines. These conveyors meter the RDF into air-lock feeders which inject it into pneumatic conveying lines that feed directly into the combustion zones of the power plant boilers 300 ft (91.3m) away. The fuel firing rate is controlled by the power plant operators by varying the bin outfeed rate.

The Power Plant

A municipal department, the Ames Minicipal Electric Service owns and operates the existing electric power generating plant. The plant consists of three boilers; two traveling grate stoker units at 95,000 lb/hr (43,091 kg/hr) and 125,000 lb/hr (56,699 kg/hr) respectively, and a suspension-fired unit at 360,000 lb/hr (163,292 kg/hr) along with the associated steam turbines and generators. The three boilers were modified during the construction of the system to accept the pneumatic conveying lines from the storage bin and the new refuse nozzles.

Current Research

The current research which began in the spring of 1976 has as a primary emphasis for the first program year the evaluation of supplemental RDF firing in the power plant. Certain aspects of the processing plant are also to be investigated. Research being conducted under grants from the Environmental Protection Agency, Energy Research and Development Agency and the American Public Power Association is being coordinated through the City of Ames. Some of the major research activities are discussed below.

Air Emissions

Sampling of sulfur oxides, nitrous oxides, and particulates from stack emissions with and without RDF firing is being done by the Engineering Research Institute (ERI), Iowa State University. Samples have been taken both before and after the particulate collector for comparison. In addition, combustion effciency is being tested via orsat tests, and sampling for other stack gas components such as aldehydes and ketones, chlorides and organic acids, heavy organics, Hg, Se, Be, HC, and N_2O are being taken. ERDA Ames Laboratory is responsible for sample analysis. Comparisons between emissions with all coal firing and with a coal/RDF supplement will be made.

RDF and RDF Ash Tests

Random sampling of the RDF as it is discharged from the bin is being done by ERI with sample analysis by ERDA Ames Laboratory. The RDF analysis will show bulk density, moisture, heating value, and proximate and ultimate analysis. RDF ash tests include identification of chemical components and tests for fusion temperature. In addition, the particle size distribution of the RDF samples is being determined.

Boiler Ash Tests

Samples of boiler bottom ash will be taken from boilers firing both coal and supplementary RDF for comparison with coal-only bottom ash.

Economic Analysis

The system economics are being analysed under subcontract to the Midwest Research Institute. Costs of operation including breakdowns for major equipment, along with revenues for metals and fuel will be identified for the system.

Bacteria Measurement

ERI is also involved in sampling for concentration of bacteria in the processing plant.

Corrosion

The American Public Power Association has contributed money earmarked for boiler corrosion studies. Corrosion test specimens are used to test for chloride and other types of corrosion.

Future Research Activities

Research for the second program year will include additional boiler performance testing along with evaluation of the processing line performance. The specific research tasks for the second year have not yet been defined.

Research Needs

Experience with the operation of the system during its first year has shown certain general areas toward which research should be directed.

Processing Plant

Dust Control.--During the plant design, dust problems were undefined. Certain dust control equipment was incorporated into the design, however, it was determined that expensive equipment should not be added until operating experience could show the true nature of the problem. Research is now needed to identify the points in the process line which generate dust and to find the best methods for its control.

Shredders.--Shredder maintenance as anticipated, has been a major operating cost during the initial year of operation. Hammer replacement costs are the major cost items. Literature on solid waste shredding is available.[1] However, it is clear that little is known about the interactions of variables such as:

1. Rotor size and speed
2. Rotor rotational inertia
3. Grate sizes and geometry
4. Motor horsepower
5. Hammer size and geometry
6. Material composition
7. Material density
8. Material Moisture content
9. Internal Shredder volume
10. Shredder capacity (TPH)

For instance, a phenomenon noted by the plant operators is shown in Figure 3. It shows that as new hammers begin to wear, capacity (measured in material throughput) increases without degradation of the material product. Wear continues to increase the capacity to a certain point, then capacity sharply decreases as wear continues. Perhaps this phenomenon indicates the need for new hammer geometry. Research could be directed toward identifying the reasons for this variation, and designs to keep shredder operation in the optimum range could be determined. Research is needed to determine the interactions of all of the variables listed above.

Bacteria.--Further research into the effects of bacteria on operating personnel should have a high priority. Research should identify which bacteria are harmful, what exposure durations are harmful, and which control methods are the most effective.

Costs.--In addition, the costs for operation and maintenance for all major equipment items should be identified to help with future design. Important equipment items are: shredders, conveyors, magnetic separation equipment, air density separator, and nonferrous separator.

Storage

RDF Density.--Currently, the outfeed weighing system operates by measuring a volume, assuming a material density and taking into account the drag conveyor speed. The system is not very accurate because an appropriate material density has not been identified. The problem is that as the bin is emptied, material is taken from the increasingly dense core of the conical pile. Density variations with bin fullness need to be identified.

Pneumatic Line Wear.--The pneumatic conveying lines leading in and out of the storage bin, as expected have required regular maintenance. Specifically, the replaceable wearbacks at the elbows initially showed more wear than expected. By trial-and-error methods, a satisfactory wearback material has been found. It is clear, however, that very little is known about how pneumatic line wear is effected by RDF quality (e.g. particle size, glass and grit content, composition, etc.), conveying velocity, elbow geometry, and wearback material. As an example, Figure 4 shows the storage bin and 14-inch (35.6 cm) diameter pneumatic line from the processing plant. Plant operators reported that the elbow at the top of the bin wore through considerably faster than the elbow turning up from the bottom. The reasons for this phenomenon are not clear. Research is needed in the area of pneumatic conveying of RDF.

Power Plant

Particle Size.--In the suspension fired unit, RDF particle size has proven to be critical to its efficient combustion. Very little is known about what particle sizes are optimum for different suspension-firing systems and for different sizes of boilers. It seems that a larger particle size may be feasible for a larger boiler because of a longer retention time in a larger furnace. In addition, a cyclone type suspension firing scheme may require a different particle size for efficient combustion than the tangential system in Unit #7 at Ames.

It has been suggested that dump grates may be a good way to assure the complete combustion of RDF particles. With these grates, the particle size could possibly increase. The technical and economic trade-offs of the installation of dump grates versus a system which produces a smaller particle size need to be identified. The RDF nozzles in the suspension-fired unit are the non-tilting type. It has been suggested that perhaps the nozzle tilt angle may effect RDF particle burn-out. Investigations in this area need to be done.

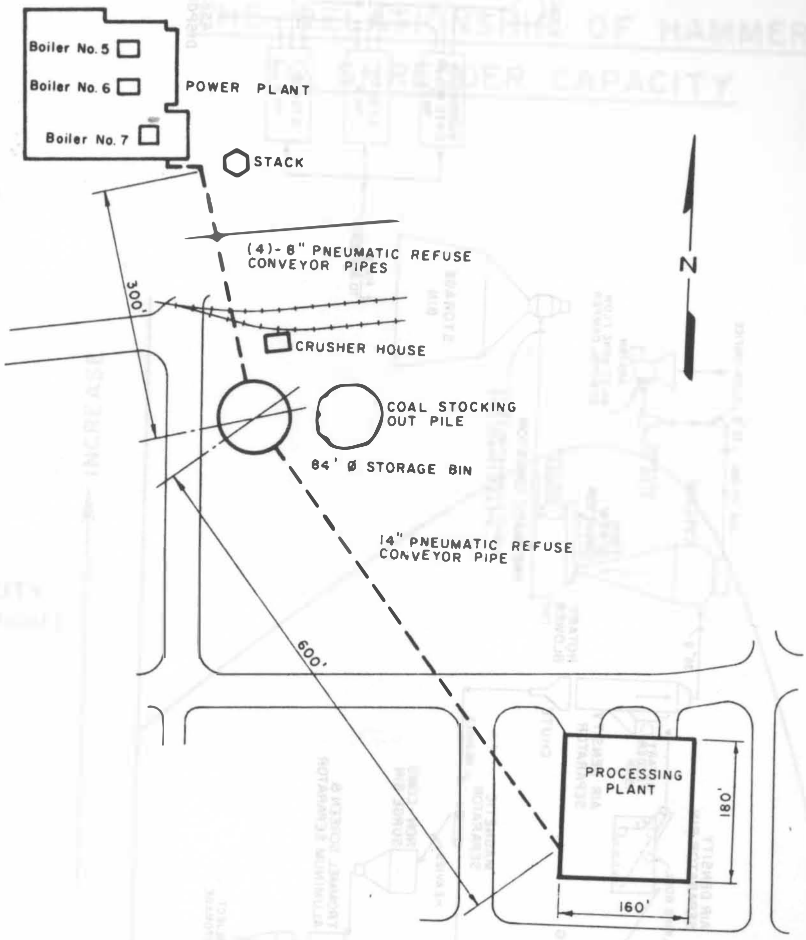
Conclusions

Research currently being conducted or planned will answer many of the questions about the separation and combustion of the light fraction of municipal solid waste in steam generators. However, research should be given priority in the areas of dust control, shredder design, bacteria control, equipment costs, RDF density, pneumatic line wear, and optimum RDF particle size to further reduce the uncertainty in the design and operation of similar systems.

References

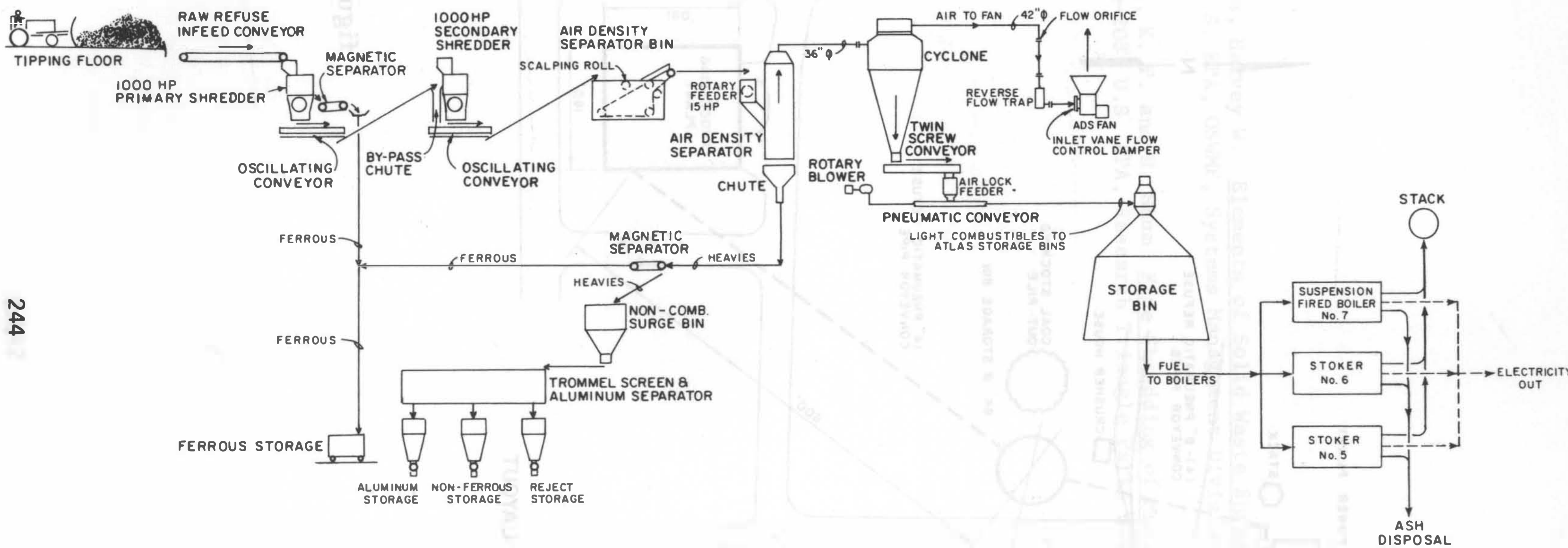
[1]Rogers, Harvey W. Elements of Solid Waste Shredding and Shredder Selection, U.S. EPA, OSWMP, Systems Management Division, November 1974.

[2]Anath, K. P. and H. Shum Fine Shredding of Municipal Solid Waste, EPA-600/2-76-208, U.S. EPA, Research Triangle Park, North Carolina, July 1976.



SITE LAYOUT

figure 1



FLOW DIAGRAM

figure 2

THE RELATIONSHIP OF HAMMER TO SHREDDER CAPACITY

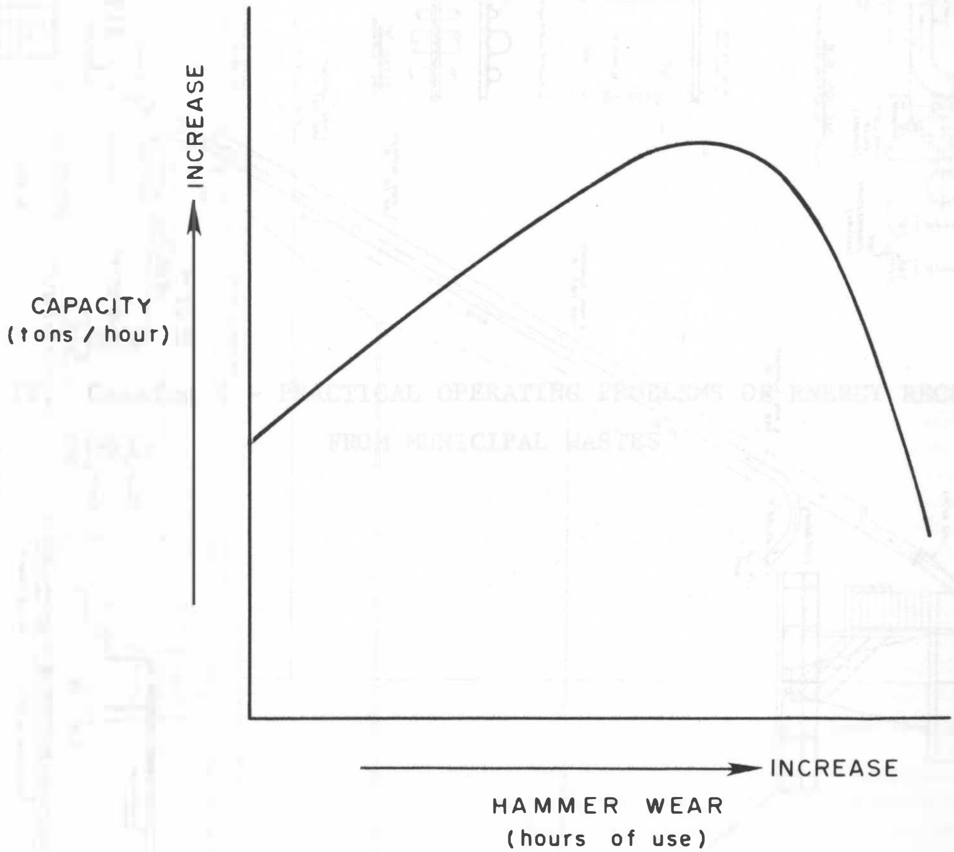
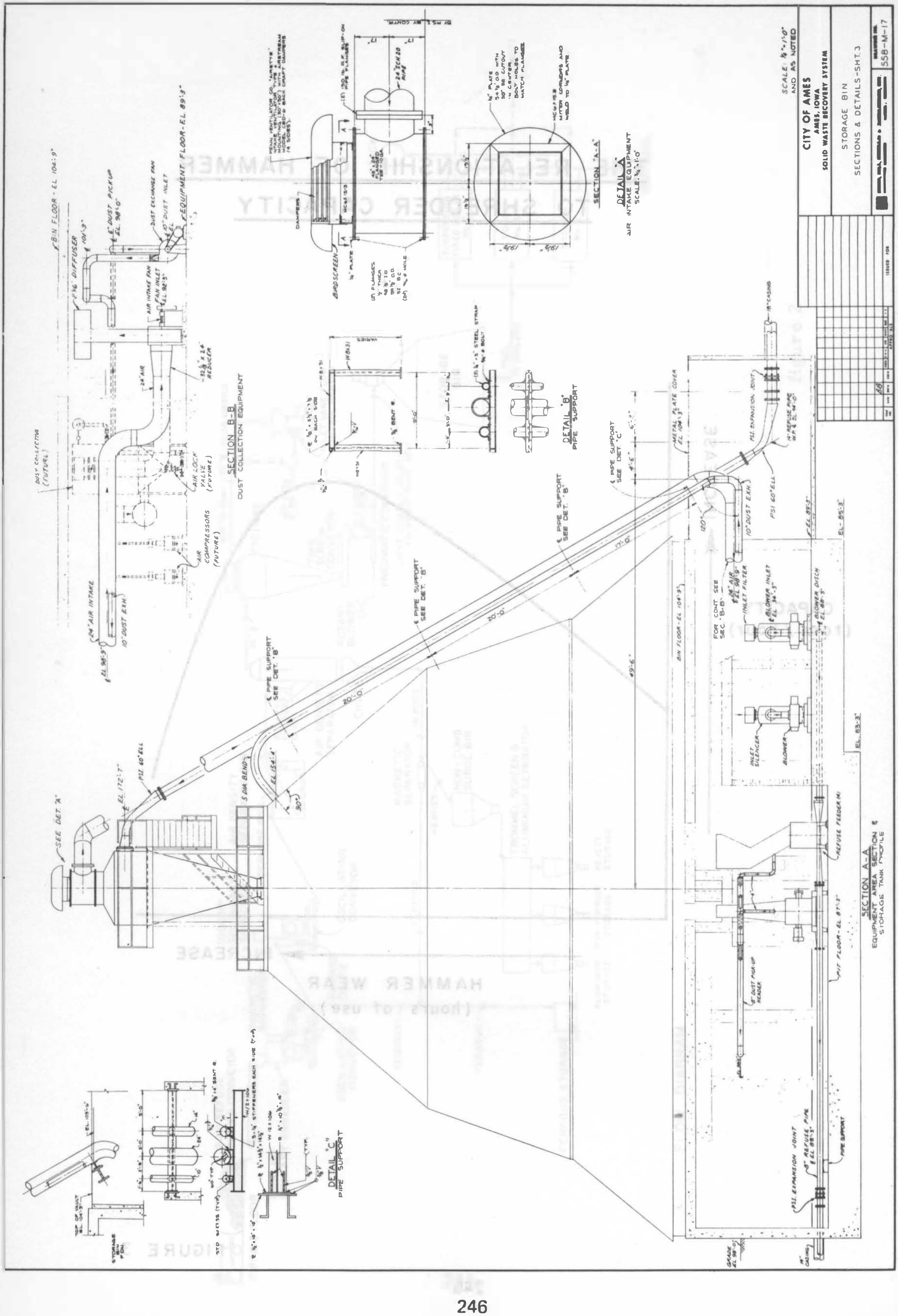


FIGURE 3


CITY OF AMES
AMES, IOWA
SOLID WASTE RECOVERY SYSTEM
STORAGE BIN
SECTIONS & DETAILS-SHT.3
SCALE: ¼"=1'-0" AND AS NOTED
558-M-17
SECTION A-A
EQUIPMENT AREA SECTION & STORAGE TANK PROFILE
SECTION B-B
DUST COLLECTION EQUIPMENT
DETAIL "A"
AIR INTAKE EQUIPMENT
SECTION "A-A"
DETAIL "B"
PIPE SUPPORT
DETAIL "C"
PIPE SUPPORT
BIN FLOOR - EL 104'-9"
EQUIPMENT FLOOR - EL 89'-3"
24" AIR INTAKE
10" DUST EXH.
AIR COMPRESSORS (FUTURE)
AIR LOCK VALVE (FUTURE)
DUST COLLECTOR (FUTURE)
SEE DET. "A"
PSI 60° ELL
5 DIA BEND
METAL PLATE COVER
PSI EXPANSION JOINT
BLOWER INLET
BLOWER DISCH
INLET SILENCER
BLOWER
INLET FILTER
REFUSE FEEDER
PIT FLOOR - EL 87'-3"
8" DUST PICK-UP HEADER
PIPE SUPPORT
BIRDSCREEN
DAMPERS
figure 4