

OPERATING EXPERIENCE AND PERFORMANCE OF TWO WET ASH HANDLING SYSTEMS USED IN MASS BURNING SOLID WASTE FACILITIES

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ABSTRACT

The relative merits of the various methods of handling residue in Refuse-to-Energy Plants has been the topic of many discussions. This paper addresses the operating history of two wet-ash handling systems:

(a) Hampton, Virginia—in operation approximately 5 years

(b) New Hanover County, North Carolina—in operation over 1 year

These two systems are similar in size and design. Both plants are mass-fired.

The paper discusses residue weight and moisture content, frequency of equipment breakdown, normal maintenance procedure, operating (maintenance) costs and recommendations for improvements.

INTRODUCTION

The use of drag conveyors in a quench basin arrangement is one of the most commonly used methods of handling residue. This method has, in fact, been in use in this country since the late 1940's, primarily in incinerator plants. Several such "first generation" plants are still in operation. One example is the City of Montreal Incinerator which operates very successfully using dual quench drag conveyors.

The original drag chain and flights, 14 years old, are still in use. They have never had a shutdown due to conveyor failure.

In order that we may discuss state of the art design, however, the data presented will be from two of the newer Refuse-to-Energy plants.

System Description—Hampton, Virginia (Figs. 1 and 2)

The bottom ash system at Hampton includes two 4 ft 6 in. wide \times 4 ft deep (1.27 m \times 1.22 m) drag conveyors set in concrete troughs. The conveyors also have 45 deg. inclined sections which are approximately 37 ft (11.28 m) long and rise approximately 14 ft (4.27 m) above grade for discharge through chutes into trucks. Each conveyor is designed to handle the residue and fly ash from the two 100 TPD (91 tpd) boiler trains. The second unit is for standby. Each trough holds about 7500 gal (28,388 L) of water for quenching of the residue. Fly ash from the hoppers under the convection bank and the economizer is discharged through 8 in. (0.20 m) rotary seal valves into the rear of the furnace and through bifurcated chutes onto the residue conveyors.

The fly ash collected continuously from the two troughed electrostatic precipitators is conveyed by means of two trains, each having two conveyors. The

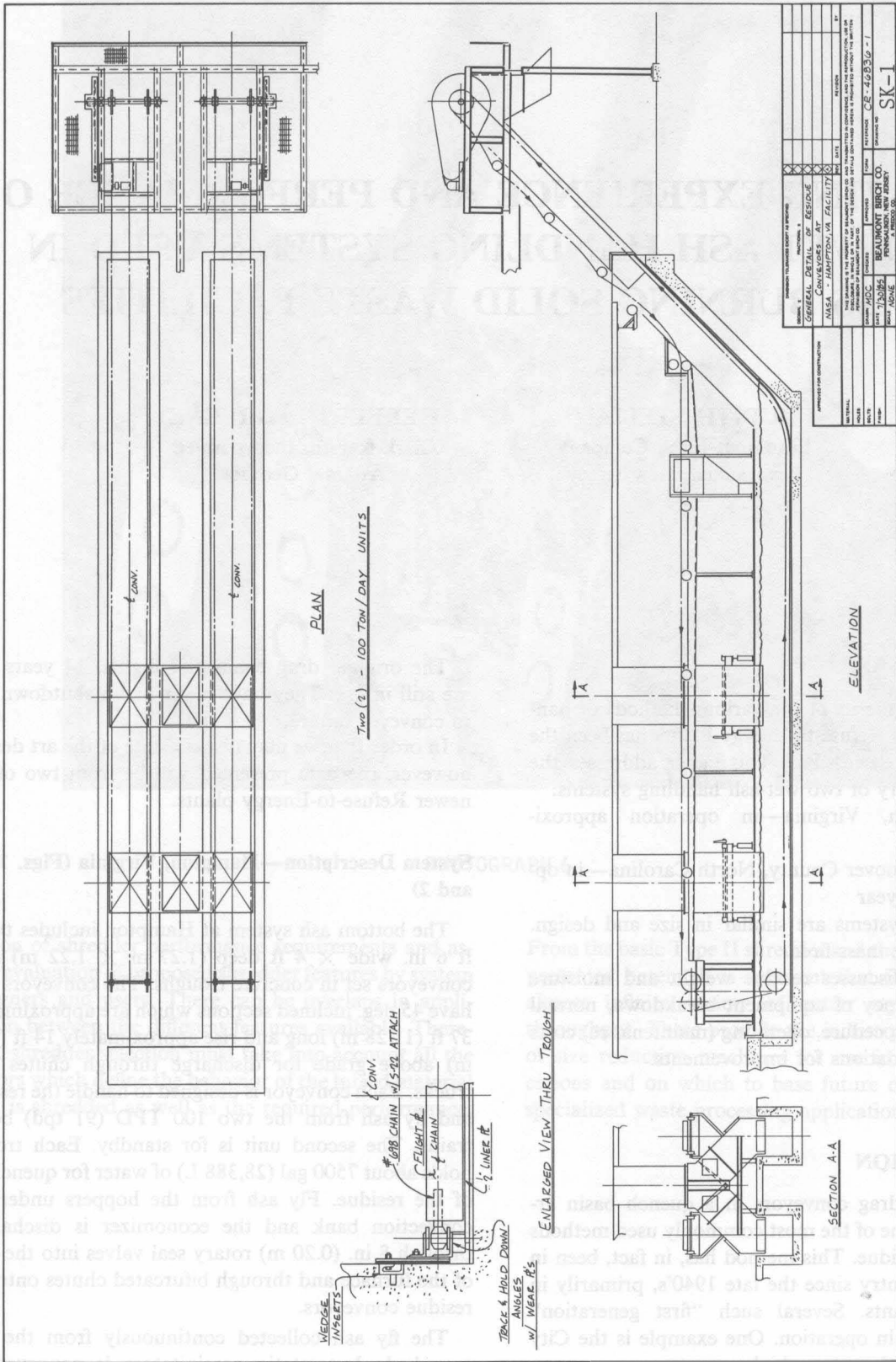


FIGURE 1

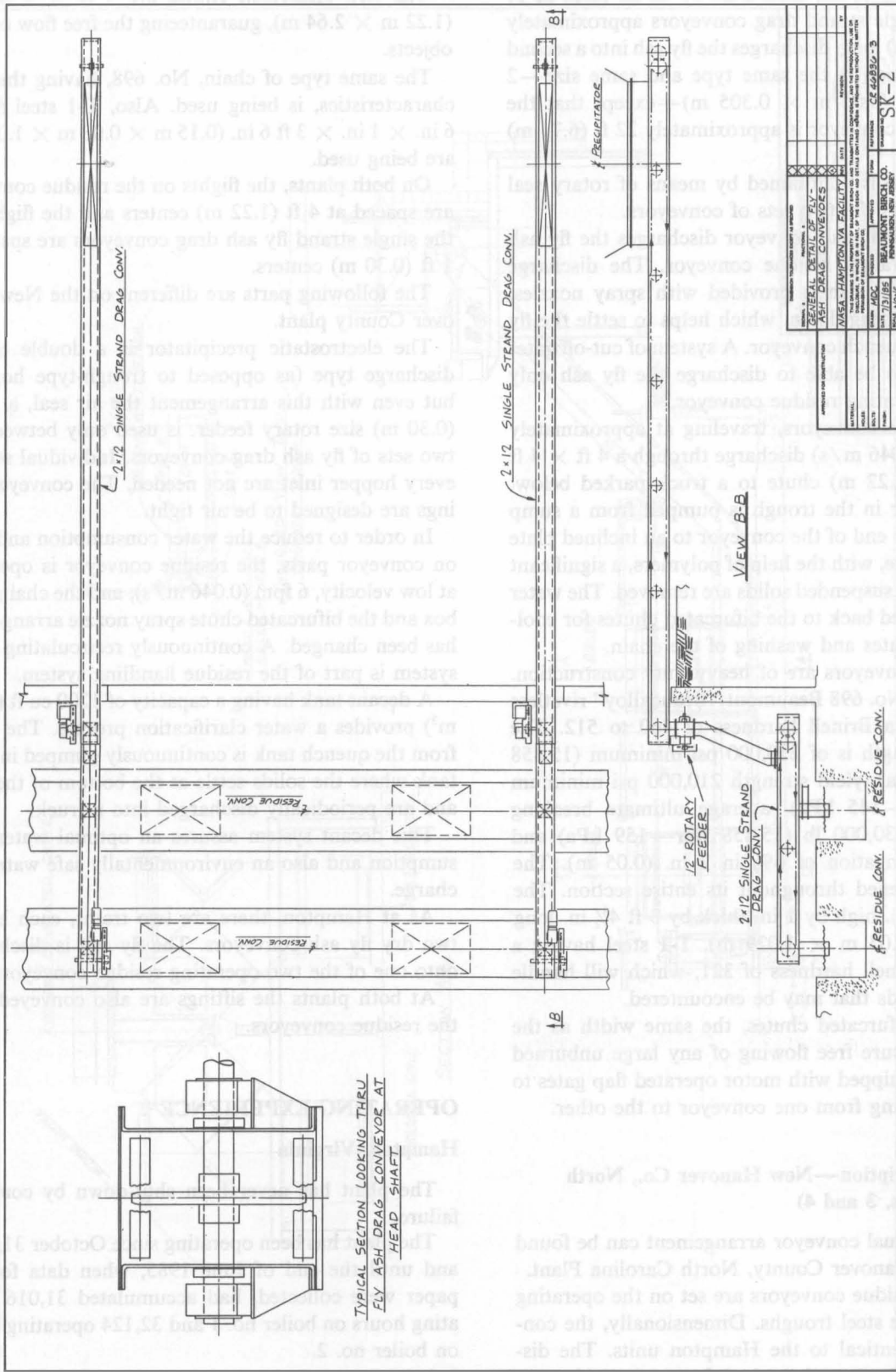


FIGURE 2

first set of conveyors, each 2 in. \times 12 in. (0.05 m \times 0.305 m) single strand drag conveyors approximately 53 ft (16.15 m) long, discharges the fly ash into a second conveyor, which is the same type and same size—2 in. \times 12 in. (0.05 m \times 0.305 m)—except that the length of the conveyor is approximately 22 ft (6.71 m) long.

The air seal is maintained by means of rotary seal valves between the two sets of conveyors.

The second fly ash conveyor discharges the fly ash into the operating residue conveyor. The discharge chute of the fly ash is provided with spray nozzles, assuring a wetting down, which helps to settle the fly ash into the quench conveyor. A system of cut-off gates is provided to be able to discharge the fly ash only onto the operating residue conveyor.

The residue conveyors, traveling at approximately 9 ft/min, (0.046 m/s) discharge through a 4 ft \times 4 ft (1.22 m \times 1.22 m) chute to a truck parked below. Quench water in the trough is pumped from a sump at the take-up end of the conveyor to an inclined plate clarifier, where, with the help of polymers, a significant portion of the suspended solids are removed. The water is then pumped back to the bifurcated chutes for cooling of the chutes and washing of the chain.

Residue conveyors are of heavy duty construction. The chain is No. 698 Beaumont "Beucalloy" rivetless type, having a Brinell hardness of 460 to 512. The ultimate strength is of 230,000 psi minimum (15,858 Bar—159 kPa), yield strength 210,000 psi minimum (14,479 Bar—145 kPa), average ultimate breaking strength of 230,000 lb (15,858 Bar—159 kPa) and minimum elongation of 6% in 2 in. (0.05 m). The chain is hardened throughout its entire section. The flights are 6 in. high by 1 in. thick by 3 ft 4½ in. long (0.15 m \times 0.03 m \times 1.029 m), T-1 steel having a minimum Brinell hardness of 321, which will handle the heavy loads that may be encountered.

The two bifurcated chutes, the same width as the furnace to assure free flowing of any large unburned pieces, are equipped with motor operated flap gates to enable switching from one conveyor to the other.

System Description—New Hanover Co., North Carolina (Figs. 3 and 4)

The same dual conveyor arrangement can be found at the New Hanover County, North Carolina Plant.

The two residue conveyors are set on the operating floor and have steel troughs. Dimensionally, the conveyors are identical to the Hampton units. The discharge chute is approximately 4 ft \times 4 ft (1.22 m \times 1.22 m).

The two bifurcated chutes are 4 ft \times 8 ft 8 in. (1.22 m \times 2.64 m), guaranteeing the free flow of large objects.

The same type of chain, No. 698, having the same characteristics, is being used. Also, T-1 steel flights, 6 in. \times 1 in. \times 3 ft 6 in. (0.15 m \times 0.03 m \times 1.097 m) are being used.

On both plants, the flights on the residue conveyors are spaced at 4 ft (1.22 m) centers and the flights for the single strand fly ash drag conveyors are spaced at 1 ft (0.30 m) centers.

The following parts are different on the New Hanover County plant.

The electrostatic precipitator is a double hopper discharge type (as opposed to trough-type hoppers) but even with this arrangement the air seal, a 12 in. (0.30 m) size rotary feeder, is used only between the two sets of fly ash drag conveyors. Individual seals at every hopper inlet are not needed. The conveyor casings are designed to be air tight.

In order to reduce the water consumption and wear on conveyor parts, the residue conveyor is operating at low velocity, 6 fpm (0.046 m/s), and the chain wash box and the bifurcated chute spray nozzle arrangement has been changed. A continuously recirculating water system is part of the residue handling system.

A decant tank having a capacity of 1200 cu ft (33.96 m³) provides a water clarification process. The water from the quench tank is continuously pumped into the tank where the solids settle at the bottom of the tank and are periodically discharged into a truck.

This decant system assures an optimal water consumption and also an environmentally safe water discharge.

As at Hampton, there are two trains, each having two dry fly ash conveyors. The fly ash is discharged onto one of the two operating residue conveyors.

At both plants the siftings are also conveyed onto the residue conveyors.

OPERATING EXPERIENCE

Hampton, Virginia

The plant has never been shut-down by conveyor failure.

The plant has been operating since October 31, 1980 and until the end of June 1985, when data for this paper were collected, had accumulated 31,016 operating hours on boiler no. 1 and 32,124 operating hours on boiler no. 2.

- (a) Average Plant Utility—78%
- (b) Conveyor Utility—100%

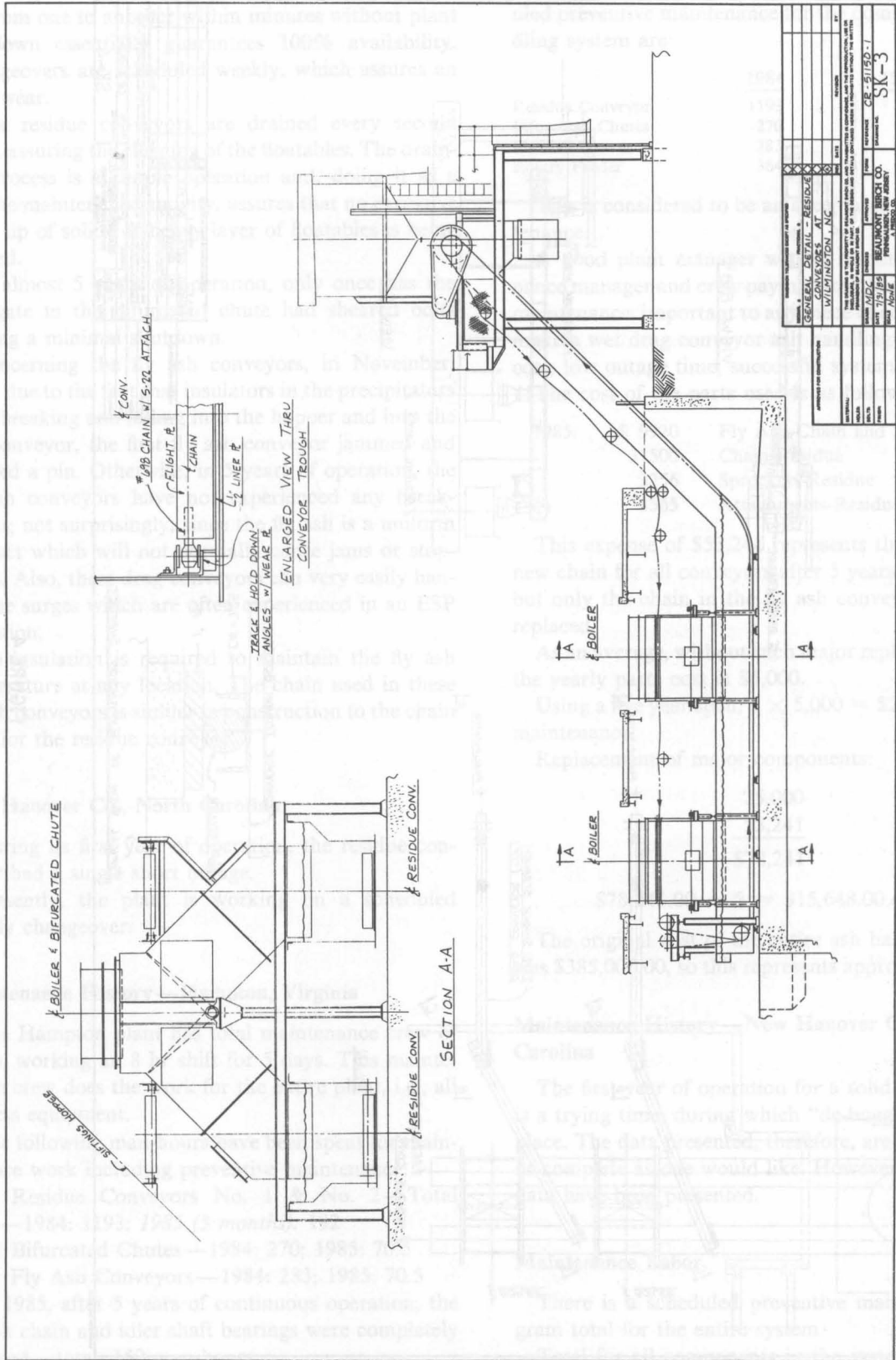
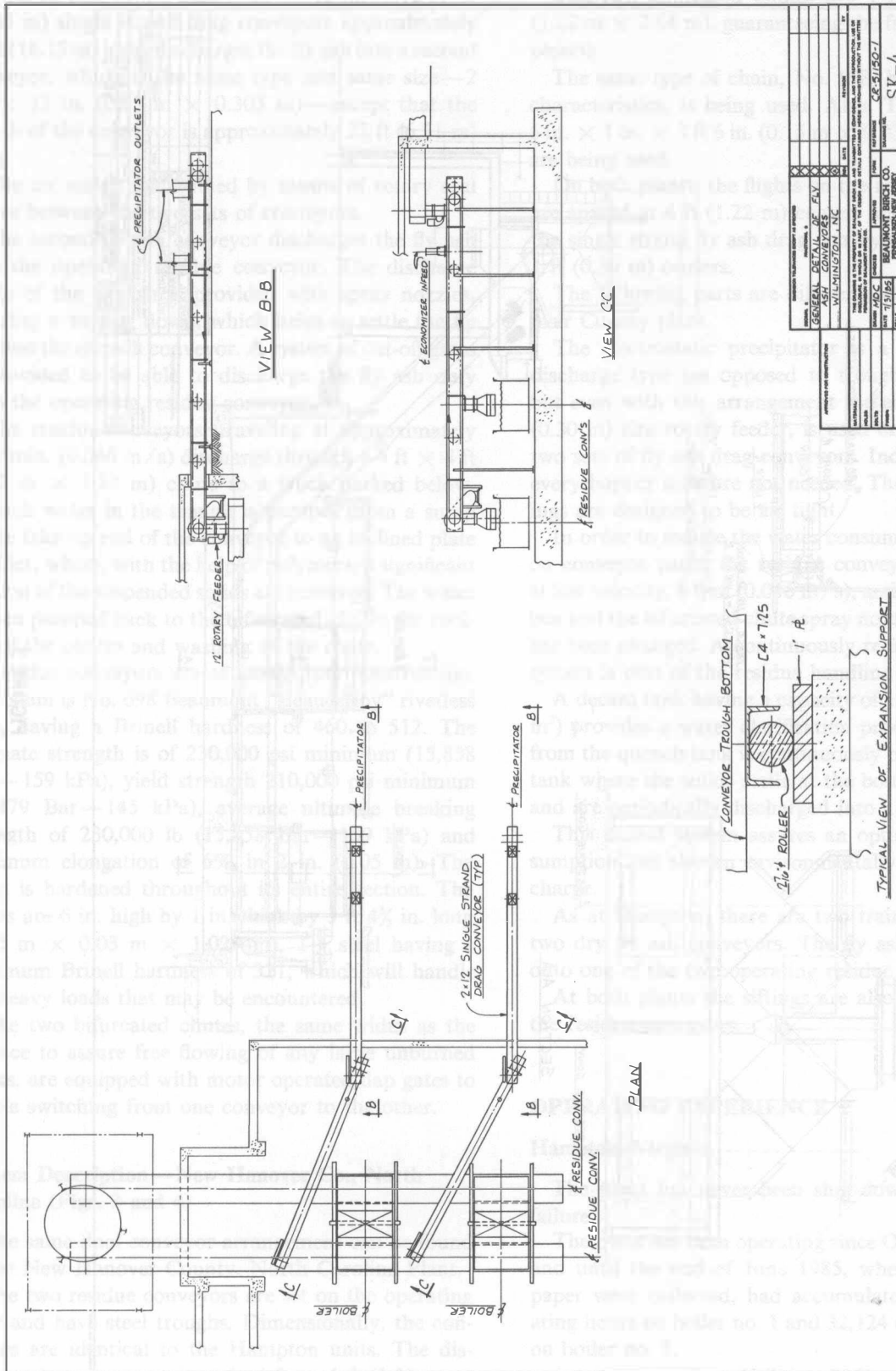


FIGURE 3



GENERAL INFORMATION PROJECT NO. CE-31120-1 SHEET NO. SK-4 DATE 1/15/84 DRAWN BY CHECKED BY APPROVED BY		REVISIONS NO. DESCRIPTION 1.
CONTRACT INFORMATION CONTRACT NO. CONTRACT DESCRIPTION PROJECT LOCATION PROJECT OWNER		DATE BY FOR
COMPANY INFORMATION COMPANY NAME ADDRESS CITY STATE ZIP		PROJECT NO. SHEET NO. DATE BY FOR

FIGURE 4

Having two conveyors with the capability of switching from one to another within minutes without plant shutdown essentially guarantees 100% availability. Changeovers are scheduled weekly, which assures an even wear.

The residue conveyors are drained every second week, assuring the cleaning of the floatables. The draining process is a simple operation and, doing it as a routine maintenance activity, assures that no excessive build up of solids or heavy layer of floatables is being formed.

In almost 5 years of operation, only once has the flap gate in the bifurcated chute had sheared bolts causing a minimal shutdown.

Concerning the fly ash conveyors, in November, 1982, due to the fact that insulators in the precipitators were breaking and falling into the hopper and into the dry conveyor, the first fly ash conveyor jammed and sheared a pin. Otherwise, in 5 years of operation, the fly ash conveyors have not experienced any breakdowns; not surprisingly, since the fly ash is a uniform product which will not normally cause jams or stoppages. Also, these drag conveyors can very easily handle the surges which are often experienced in an ESP operation.

No insulation is required to maintain the fly ash temperature at any location. The chain used in these fly ash conveyors is similar in construction to the chain used for the residue conveyor.

New Hanover Co., North Carolina

During its first year of operation, the residue conveyor had a single short outage.

Presently, the plant is working on a scheduled weekly changeover.

Maintenance History—Hampton, Virginia

The Hampton plant has total maintenance crew of seven, working an 8 hr shift for 5 days. This maintenance crew does the work for the entire plant, i.e., all process equipment.

The following man-hours have been spent for maintenance work including preventive maintenance:

(a) Residue Conveyors No. 1 & No. 2—Total Year—1984: 1193; 1985 (3 months): 192

(b) Bifurcated Chutes—1984: 270; 1985: 70.5

(c) Fly Ash Conveyors—1984: 283; 1985: 70.5

In 1985, after 5 years of continuous operation, the fly ash chain and idler shaft bearings were completely replaced—total: 150 man-hours.

(d) Rotary Feeders—1984: 364; 1985: 81

The total maintenance man-hours including scheduled preventive maintenance for the complete ash handling system are:

	1984	1985 (3 months)
Residue Conveyor	1193	192
Bifurcated Chutes	270	70.5
Fly Ash Conveyor	283	70.5
Rotary Feeder	364	81

This is considered to be an acceptable level of maintenance.

A good plant manager with a responsible maintenance manager and crew paying attention to preventive maintenance, important to any piece of equipment, can make a wet drag conveyor ash handling system a low cost, low outage time, successful system.

The cost of the parts used is as follows:

1985: \$ 9920	Fly Ash Chain and Attachments
31500	Chain-Residue
3256	Sprockets-Residue
8565	Attachments-Residue

This expense of \$53,241 represents the purchase of new chain for all conveyors after 5 years of operation, but only the chain in the fly ash conveyors has been replaced.

As an average, without such major replacement cost, the yearly parts cost is \$5,000.

Using a five year span, $5 \times 5,000 = \$25,000$ routine maintenance.

Replacement of major components:

25,000
<u>53,241</u>
\$78,241

$$\$78,241.00 \div 5 = \$15,648.00/\text{year}$$

The original cost of the entire ash handling system was \$385,000.00, so this represents approximately 4%.

Maintenance History—New Hanover Co., North Carolina

The first year of operation for a solid waste facility is a trying time, during which "de-bugging" is taking place. The data presented, therefore, are not as typical or complete as one would like. However, all available data have been presented.

Maintenance Labor

There is a scheduled preventive maintenance program total for the entire system.

Total for all components in the system—528 man hours/year.

Bottom Ash (residue) only—126 man hours/year.

Fly Ash: Rotary Valves; siftings:—402 man hours/year.

Cost of Parts Replaced

The cost of the system was \$728,900. During the first year of operation, the cost of replacement parts was \$9767 or 1.34% of the capital cost. Since the operators were on a learning curve with the recirculating system, most of these costs represent ash water pump replacement parts. The nature of the product being handled is such that pump selection and operating procedures are extremely critical.

Ash Characteristics

Just as it is difficult to obtain "representative samples" of MSW, so it is with bottom ash or "residue". The same problem exists in attempting to assure that a sample contains the proper portion of ferrous and nonferrous metals, glass, fly ash, bottom ash, etc. With that in mind, three samples of residue were taken from the Hampton system, one from the truck and two from the ash discharge chute. The three samples were weighed, baked in an oven, and weighed again showing the moisture content to be 30.56%, 28.57% and 24.14% respectively, for an average of 27.75%. Three samples taken from residue trucks in 1981 and tested in the same fashion showed a moisture content of 29%. The wet residue weighed 56.23 lb/ft³ (900.72 kg/m³).

At New Hanover County, two samples were taken in 1984 and checked for moisture content of 35.8%. The difference between New Hanover and Hampton may be due to a longer inclined section for dewatering.

Fly Ash, measured at different plants had an average bulk density of 15 lb/cu ft (240.28 kg/m³) ranging from a low of 7 lb/cu ft (112.13 kg/m³) and up to

25 lb/cu ft (400.46 kg/m³). The weight of the fly ash is greatly influenced by its fluidizing state. Fly ash can be compressed easily, in which case the bulk density would increase possibly up to 35 lb/cu ft (560.65 kg/m³).

CONCLUSIONS AND RECOMMENDATIONS

Even though the two reference plants are considered successful, there is room for improvement.

As discussed earlier, both plant designs include redundant residue conveyors. Due to the severe service to which these units are exposed and the nature of the product being handled, this redundancy is considered a must.

Secondly, the procedure of changing from one conveyor to the other on a weekly basis provides even wear on parts and allows scheduled maintenance to be performed on the unused conveyor, assuring more reliable operation.

Conveyors should be run at low velocities in the 5–10 ft/min (0.025 m/s–0.050 m/s) range to minimize wear and assure a good dewatering, minimizing the moisture content.

A preventive maintenance program is an absolute necessity. Exposing a potential problem before it becomes a fact can reduce maintenance costs. Proper attention to daily and/or weekly service, lubrication, etc. minimizes wear and tear on the equipment. Ash water pumps should be of the highest quality and redundancy should be provided.

Capital costs will be returned through reduced maintenance and downtime.

We believe the wet ash handling system is a viable approach to handling residue from municipal solid waste plants.

Key Words: Ash; Density; Fly Ash; Maintenance; Residue