



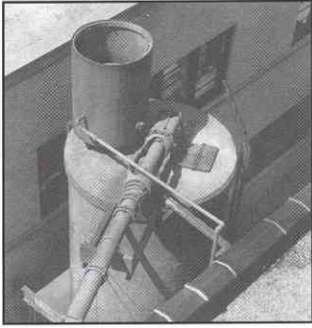
**UNITED  
CONVEYOR  
CORPORATION**



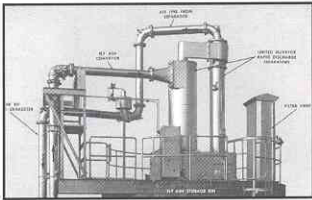
**VACUUM CONVEYING SYSTEMS**  
**NEGATIVE PRESSURE MATERIAL HANDLING SYSTEMS**



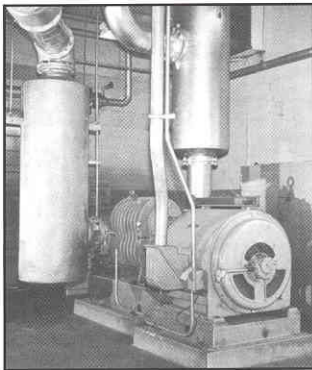
# A BRIEF HISTORY OF UCC VACUUM SYSTEMS



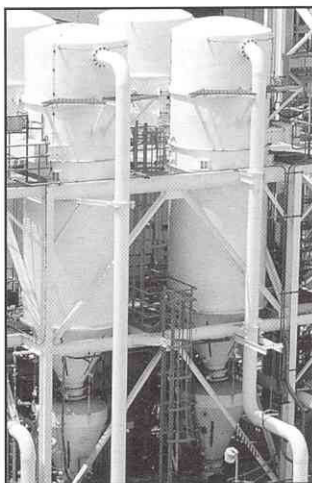
STEAMATIC system  
1928



Primary & Secondary  
Separators  
1930



Mechanical exhauster  
1948



Filter/Separator  
1988

**1923** -- Steam jet intake moves ash from floor grates and propels it through conveying line

**1928** -- Patented STEAMATIC exhauster uses available steam to convey ash through the exhauster, mixed with steam

**1930** -- Patented NUVEYOR® receiver allows separation of ash from the air stream using a primary and secondary separator

**1933** -- Patented NUVATROL control panels add automation and allow system to be operated without manual labor, activated by no load vacuum

**1944** -- Patented HYDROVEYOR® exhauster uses available high pressure water to power the vacuum system and remove ash as a slurry to a retention pond

**1948** -- Mechanical exhauster provides an alternative to the use of steam and water as a vacuum producer

**1957** -- Patented Rotary Slide Gate allows positive isolation of branch lines for more effective control

**1959** -- Discharge delay technology allows hot material to be discharged into the bin, controlling expansion of air in the bin

**1960** -- Ash feed control adds first interactive control of intakes to allow for efficient full load control and reduce system wear

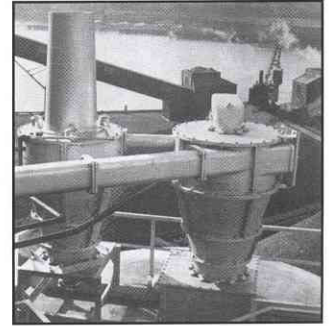
**1963** -- EXCEN CRUSHER® single-roll units crush bottom ash clinkers for more efficient operation of dry systems

**1988** -- Combination Filter/Separator replaces primary, secondary, and tertiary separators with a single highly efficient unit

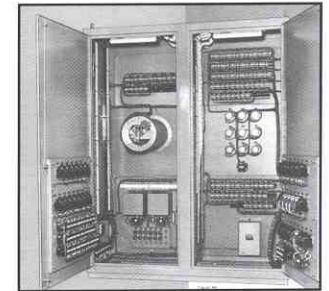
**1995** -- 40D Knife Gate provides a lighter weight alternative to slide gates, with high reliability and low maintenance

**1996** -- Patented PAX™ Pneumatic Ash Extractor, a dry bottom ash system, uses a vacuum system to eliminate water when conveying bottom ash

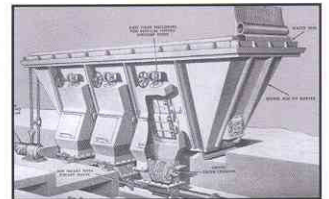
**1998** -- Flue gas reduction logic improves full logic control and greatly reduces volume of flue gas admitted to the vacuum system



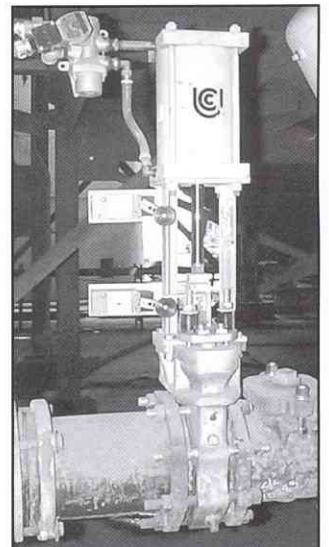
NUVEYOR system  
1930



NUVATROL panel  
1933



Dry Hopper with  
EXCEN CRUSHER  
1963



40D Knife Gate  
1995

## ADVANTAGES OF A VACUUM SYSTEM

Vacuum conveying systems are the most prevalent ash handling systems in North America. Some reasons for this widespread use are:

- Single valve required at each hopper minimizes installation cost, maintenance time, and replacement costs
- Least headroom of any pneumatic system allows baghouse or precipitator to be built with minimum support steel
- Negative pressure under the hopper assists removal of material from the hopper
- No external leakage of material - air leaks inward assuring a clean system
- Broad range of materials can be conveyed, and system modifications are normally not required with change in fuel type

### UCC's Vacuum System Design

UCC has installed hundreds of vacuum systems around the world. Included in these are systems of higher capacity and longer distance than our competitors were able to supply.

A major part of our ability to supply systems that others could not is the vacuum system test loop described to the right. UCC has tested thousands of ash samples from hundreds of power plants burning various fuels. The results of these tests are used to refine our vacuum system sizing program into the most comprehensive in the industry.

### UCC Component Design

UCC's design expertise also results in superior components. Over the last 40 years, UCC has designed specialty gates, fittings, pipe, and separating equipment to withstand the rigors of 24 hours per day operation. Each component is designed for abrasive material handling, using field feedback to modify designs and improve reliability. Upset conditions occur and component designs need to accommodate these conditions. Our references speak for themselves.

Replacement parts are also readily available. An extensive inventory of parts is ready for shipment whenever they are needed. Same-day shipment from this inventory is available every day of the year, if required. UCC Representatives are available to assist whenever questions or further needs arise.



The Vacuum System test loop in UCC's development laboratory is available to determine exact material conveying characteristics. The automated control panel shown above monitors the extensively instrumented loop to provide accurate information from each test, including:

- Vacuum at different points in the system
- Vacuum drop across straight horizontal runs and risers
- Air flow
- Air velocities
- Material flow
- Material discharge profile
- Dynamic material-to-air ratios

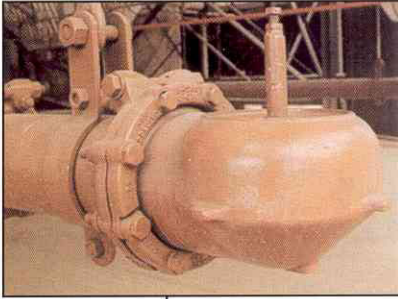
This test loop is designed to work with a single 55 gallon drum sample of material.

#### Test Loop Properties:

- Length -- 100 feet (30 meters)
- Capacity -- One Ton per Hour (0.9 MTPH)
- Pipe size -- 2 in. (50 mm)
- Three visual observation points

UCC can assist in determining the size and type of system required for each specific installation. Contact your UCC Sales Representative for further information. For a more detailed discussion of how pneumatic systems operate, see UCC publication #M0601-121: "Pneumatic Conveying Systems -- A Discussion of Flow Regimes."





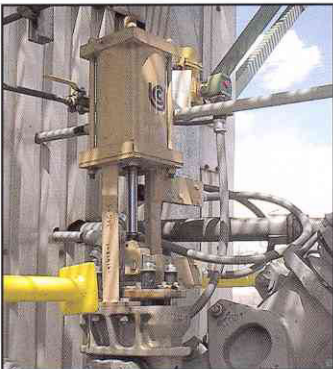
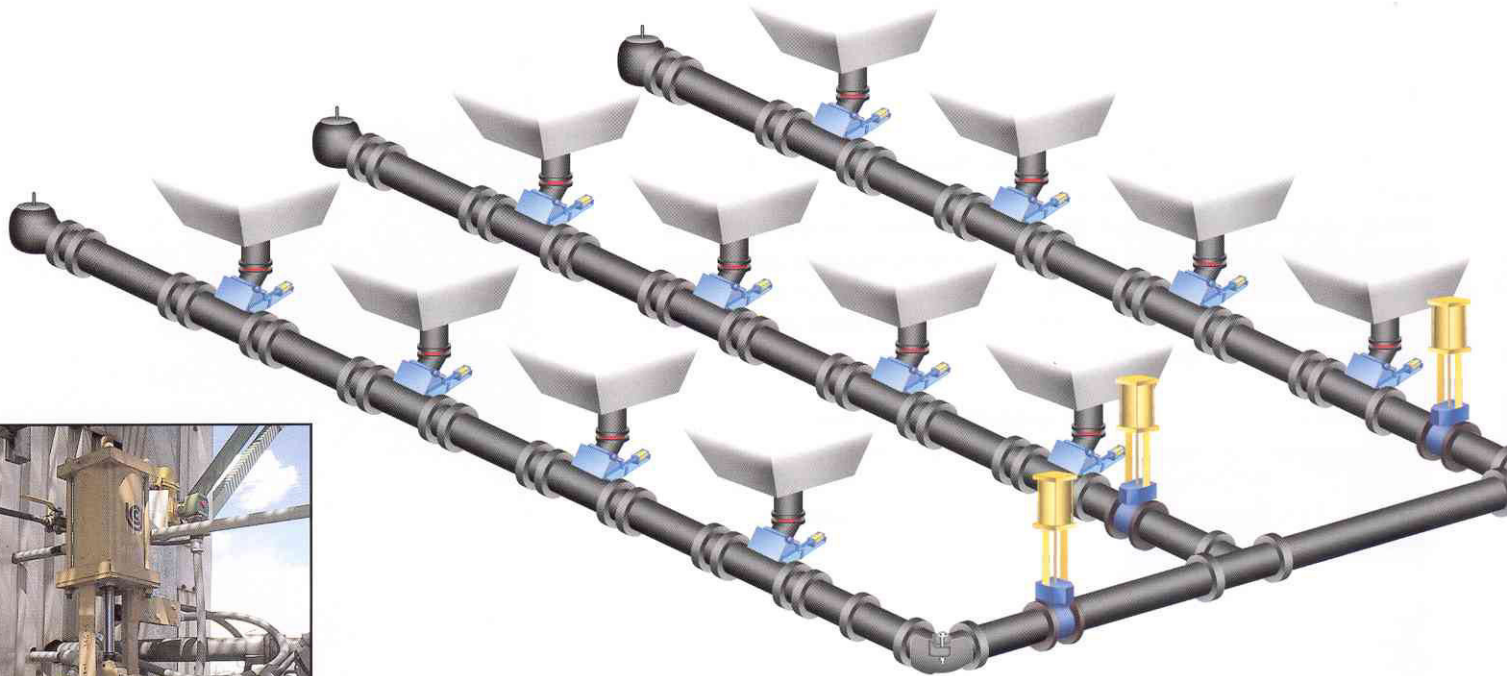
## Air Intake

Located at the end of each branch line, the air intake is an adjustable, spring-loaded check valve. It admits air into the conveying line to provide a moving air stream into which the material will drop.



## Ash Intake

Intake valves are air diaphragm or cylinder-operated for automatic remote control, trouble free operation. They provide a transition from the collection hoppers to the conveyor line and isolate the hoppers from the line while they are filling. An intake with aeration modules assures high volume flow for capacities above 45 TPH.



## Knife Gate

Specialized valves – UCC Series 40D Knife Gates – provide pipeline isolation for branch lines. These valves, specifically designed for abrasive material flow, open or close the line but do not regulate flow. Knife gates can be operated automatically with air cylinders or motors; or manually with hand or chain wheels.

## Mechanical Exhauster

Rotary positive displacement mechanical exhausters are the most widely used method to produce vacuum in conveying systems. Two alternatives are the HYDROVEYOR® water powered exhauster, and a steam exhauster powered by high pressure steam.





## Conveyor Line & Fittings

Conveyor line pipe is usually NUVALOY® plain end, low chrome ductile iron (nominal 300 BHN). Abrasion resistant DURITE® alloy wear sections (nominal 400 BHN) can be installed after a change of direction. DURITE elbows and expansion joints in UCC systems are designed to withstand abrasive wear. Carbon steel pipe with DURITE fittings can be used for less abrasive applications.



## Filter/Separator & Storage Bin

Highly efficient combination units remove material from the conveying air stream and deposit it into a storage bin. In continuously operating systems, material discharges from the filter/separator into a transfer hopper, then drops from the hopper into the bin. In systems operated intermittently, conveying is interrupted at brief intervals to discharge material directly into the bin.

UCC can provide steel or concrete bins with an aeration removal system. The aeration equipment provides a smooth flow of material from the bin discharge. Standard accessories include vent filters, relief valves, and level detectors.

## Paddle Mixer/Unloader

The twin-paddle mixer/unloader is the standard method used to unload the storage bin. The unit has two horizontal shafts with abrasion resistant paddles attached. The paddles rotate in opposite directions as nozzles spray water on the material. The mixer creates a homogeneous mixture of water and material allowing unloading into open top trucks or rail cars.

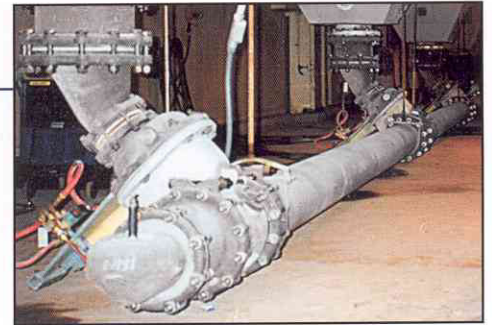
For Powder River Basin (PRB) ash, a Pin Mixer is available. It uses pins instead of paddles to mix the material with water.





## PC Boiler Fly Ash

A vacuum system is the most widely used system in North America for handling PC fly ash. These highly dependable systems can be operated continuously or intermittently. The ash is transported in an air stream at less than -20" (-530 mm) Hg. These systems have relatively low headroom requirements and the ability to stop and re-start automatically. They are designed for conveying distances up to 1500 feet (450 meters).

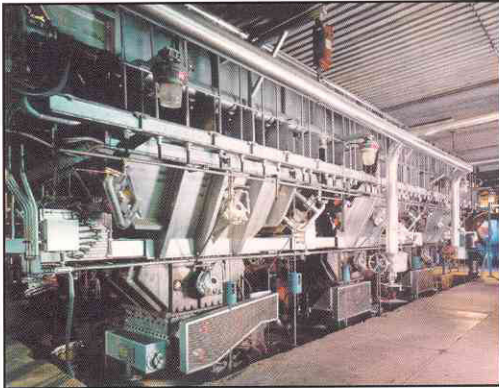


## Dry Bottom Ash

The need for water to convey bottom ash has been eliminated by applying new technology to time-proven vacuum system design. Three sub systems comprise the Pneumatic Ash Extractor -- PAX™ Dry Bottom Ash System:

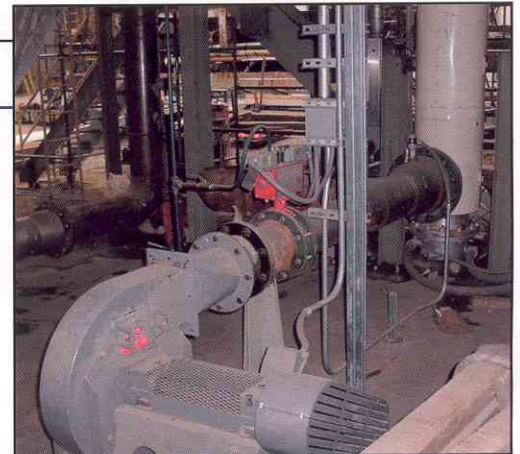
- A dry hopper where the ash is collected, crushed, and fed to a vacuum system.
- A vacuum system to remove ash from the hopper and transport it dry.
- A bin to store the ash until it can be transported to a disposal site.

For generating units from 50 to 500 MW, a PAX unit makes it possible to convey bottom ash dependably with a vacuum conveying system.  
(See UCC publication #M1197-122: PAX™ Pneumatic Ash Extractor.)



## PRB Dry Scrubber Ash

Coal from the Powder River Basin tends to produce ash with a high calcium content, and can be highly reactive when exposed to moisture. Dew point temperatures in fly ash dry scrubber baghouses can be as low as 18°F, creating an environment ideal for buildup if the material comes in contact with cool metal surfaces. A completely dry vacuum system is recommended to prevent problems with handling the ash. This can be achieved by blowing heated air through the line prior to conveying. As an alternative to heated air, rubber elbows can be used to prevent buildup at direction changes.



Other precautions must be taken when handling PRB dry scrubber ash in a vacuum system, due to the high moisture and calcium content, and the stickiness of the material. Large diameter ash intakes are used to prevent arching in the hoppers. To prevent blinding the filter bags, PTFE (polytetrafluoroethylene) membrane bags are used in the filter/separator unit. Insulation of the conveying line, exhauster airline, and filter/separator is also recommended. It is also important to maintain dry conditions in the ash storage silo -- UCC generally uses flat bottom silos with fabric fluidizing elements. Silo pressure is kept at a slight positive to ensure no ambient moisture enters the silo.



## Bed Ash

A vacuum system may also be used for spent bed ash. This type of system generally conveys from a surge tank located below a cooling screw or other cooling device, which feeds the spent material from the Fluidized Bed Combustor. Spent bed material can be transported at capacities of up to 30 tons per hour (27 metric tons). Ceramic lined ash intakes control material flow from the surge tank into the line.



## Oil Ash

When conveying oil ash or ash from orimulsion fuel from fly ash collection hoppers, the crucial elements are continuous conveying and maintaining elevated temperature. Heat tracing and insulating the collection hoppers and conveyor piping keeps the ash hot. A continuously operating vacuum system using heated air keeps the ash moving and prevents buildup in the collection hoppers.

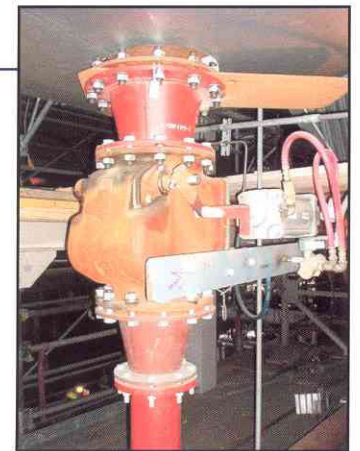
## Petroleum Coke Ash

In a petroleum coke-fired boiler, the fly ash is extremely fine and very hygroscopic. It tends to have difficult flow properties, due to its adhesion and affinity for moisture. The ash is usually handled in a vacuum system with heated air, in order to keep the material moving and at a high temperature. For FBC units burning petroleum coke, UCC has also conveyed fly ash with vacuum systems.

## SCR Additions

When a Selective Catalytic Reduction (SCR) unit is added to an existing boiler, the ash can be transported in the existing vacuum system. Ash that drops out of the gas stream in the SCR system will be similar to ash from the air heater. Hoppers must be provided to collect the ash and a conveyor branch line is added to move the ash into the pneumatic ash handling system.

If ash from the SCR unit flows freely, then the system can be operated intermittently, emptying the hoppers as necessary. In this case, standard fly ash intakes can be used to connect hoppers to the conveying line. If the ash is sticky or tends to bridge in the hopper, it may be necessary to use large, vertical intakes and operate the system continuously to empty the hoppers frequently.



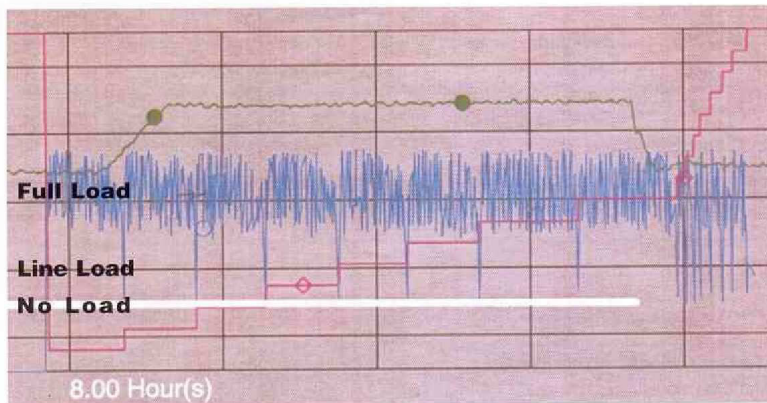
## Other Materials

Vacuum systems can be used for a variety of other dry granular materials, e.g. limestone, kiln dust, sand, and solid waste from refuse derived fuels. Samples can be tested in the UCC laboratory to determine the suitability of a vacuum system for these and other materials.

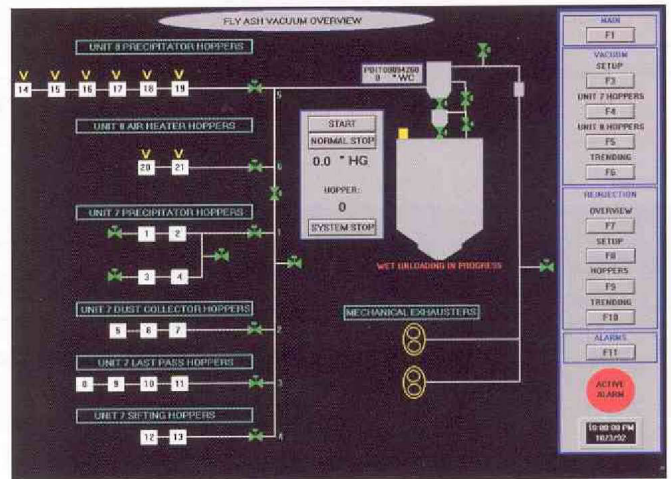
# VACUUM SYSTEM CONTROLS

Since 1960, UCC's vacuum systems have used Full Load control. This method of control allows the system to operate efficiently by monitoring the conveying line vacuum. Each intake is opened and closed intermittently to keep the ash entrained in the line, and maintain full load vacuum. As each hopper empties, the control system senses the drop to No Load vacuum, and switches to the next intake.

Vacuum systems are controlled using PLC logic for the most efficient operation. The control system includes CRT graphics to monitor the conveying system. A typical screen graphic is shown below.



Vacuum chart for a branch line with eight intakes  
 Blue - vacuum, Red - intake, Green - MW output



CRT graphic panel for a typical vacuum system.

# RANGE & PERFORMANCE SPECIFICATIONS

Vacuum systems are no longer limited to small tonnage requirements or short conveying distances. Capabilities of these systems have increased in recent years, as indicated in the table below.

NUVEYOR® SYSTEM SPECIFICATIONS	
Maximum distance	1500 ft. (450 meters)
Maximum capacity	100 TPH (90 MTPH)
Mass Ratio material : air	Up to 22 lb : lb (Kg : Kg)
Superficial starting air velocity	3000 - 5200 feet/minute (16 - 27 meters/second)
Maximum conveyor line pressure	20 inches Hg (530 mm Hg)



Descriptions of UCC equipment and services herein do not constitute a warranty or a guarantee of performance, nor is any warranty implied.