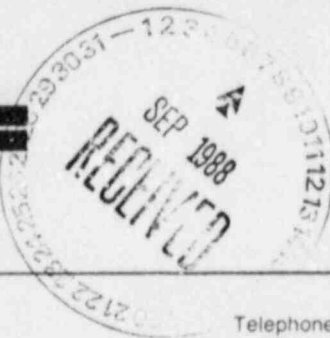


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Exploration  
Company of  
Nebraska, Inc.



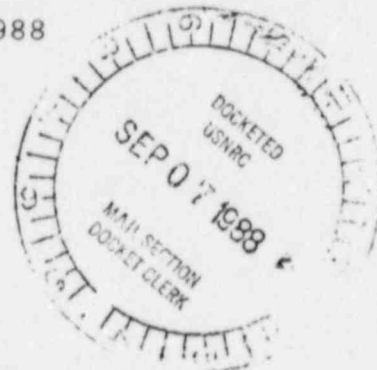
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RETURN ORIGINAL TO PDR, HQ.

315 Second Street  
P.O. Box 169  
Crawford, Nebraska 69339

Telephone:  
Office: (308) 665-2132  
Plant: (308) 665-2215  
Telecopy: (308) 665-2341

September 2, 1988

Mr. Gary Konwinski  
U.S. Nuclear Regulatory Commission  
Uranium Recovery Field Office  
Box 25325  
Denver, CO 80225



Dear Gary:

I have enclosed some information on vacuum dryers similar to what we would plan on using at the Crow Butte Project. If you have any further technical questions about the "zero discharge" aspects of this type of dryer, I would suggest you contact Bart Conroy of Resource Technologies Group in Lakewood (303-969-8511). Bart is familiar with the operation of this type of dryer unit.

Sincerely,

Ralph Knode  
Project Supervisor

Enclosure

cc: Bart Conroy  
Steve Collings

8810130018 880902  
PDR ADOCK 04008943  
C PNU

DF02  
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DESIGNATED ORIGINAL  
Certified By Mary C. Wood

FEE NOT REQUIRED  
Cost Info  
88-1200

08/24/87 15:30

☎ 1 215 831 5420

STOKES VACUUM

☐ 01



STOKES

5500 Tabor Road, Philadelphia, PA 19120 • (215) 831-5400

EQUIPMENT • CHEMICALS • HEALTH PRODUCTS

## FACSIMILE TRANSMISSION

NUMBER 128

DATE: August 24, 1987

PLEASE DELIVER THE FOLLOWING PAGE(S) ASAP TO:

NAME: Mr. Chuck Schick

COMPANY: Resource Technologies Group

FACSIMILE NUMBER: 303-985-0439

FROM: Bob Adair

COMPANY: STOKES VACUUM - PENNWALT CORPORATION  
FAX NO. 215-831-5420

TOTAL NUMBER OF PAGES INCLUDING THIS SHEET: 10

IF FOR ANY REASON YOU DO NOT RECEIVE ALL THE PAGES, CALL  
215-831-5400 AS SOON AS POSSIBLE

MESSAGE:

RE: Your Verbal Inquiry for "Yellow Cake" Vacuum Drying Equipment System

In confirmation of my verbal reply to your referenced inquiry, I specified  
and quoted O./M. pricing as follows:

1. A Stokes 59-50, 3' D x 15' L rotary vacuum drying system comprised of the following components. 106 (1)
  - a. 59-50 r.v.d., type 304 s.s. shell and agitator, carbon steel jacket, F.V. in shell, 50 p.s.i.g. at 297° F in jacket and interior of agitator.
  - 304 S.S. scraper blades, manually operated discharge door.
  - 15 HP drive system.

- b. 50-523. 25 square foot inverted bag dust filter with vibrating shaker bag motor controls including a pneumatically operated outlet butterfly valve (from the dust filter).
- c. A condensing vacuum skid which includes a Model 85 E condenser/receiver, 0 to 200 torr pressure indicating control system, liquid ring vacuum pump with closed loop, recirculating water seal system.
- d. Controls mounted on pre-piped, skid mounted condensing vacuum system.

ORDER-OF-MAGNITUDE PRICE: F.O.B. Factory, Philadelphia, PA \$280 K

DELIVERY: Approximately 28 to 30 weeks A.R.O.

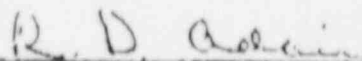
It is understood that direct steam heating up to, but not exceeding 50 p.s.i.g., would be supplied on-site by others.

Our preliminary sizing for equipment specifying and pricing was based in the following:

- 1. 1,000,000 lb./year of vacuum dried yellow cake, utilizing a <sup>260</sup><sub>200</sub> day operating year.
- 2. Initial slurry solids content of 50%.
- 3. Assumed average rate of drying of 1.75 lb. of water per hour per wetted square foot.
- 4. Assumed wet bulk density of 160 lb per cubic foot.
- 5. Assumed dry bulk density of 260 lb per cubic foot.
- 6. Assumed max. rate of evaporation (for condenser sizing) of 3.0 lb/hr x ft<sup>2</sup>.

Your interest in our Stokes rotary vacuum drying systems for the vacuum drying of Yellow Cake slurry is sincerely appreciated. When you feel that the timing is appropriate for a firm proposal with detailed specifications, please let me know and we will be delighted to comply with your request.

Truly yours,

  
R. D. Adair

Attached: 59 Specs.  
E/L Dwg. Nos. D410-817, D-50-523  
Data Sheet 490-2, Yellow Cake Data Sheet  
E. & M. Journal Reprint

cc: A. Baraty  
J. A. Lendino  
M.R. Spotts

# - FUNCTIONAL SPECIFICATIONS -

PROPOSAL NO. \_\_\_\_\_ DATE \_\_\_\_\_  
 CUSTOMER \_\_\_\_\_ CUSTOMER ORDER NO. \_\_\_\_\_  
 STOKES ORDER NO. \_\_\_\_\_

JACKET DESIGN PRESSURE \_\_\_\_\_ NO. SIG. A  
 JACKET DESIGN TEMPERATURE \_\_\_\_\_ 300°F. A  
 AGITATOR DESIGN PRESSURE \_\_\_\_\_ 30 PSIG. A  
 AGITATOR DESIGN TEMPERATURE \_\_\_\_\_ 300°F. A  
 DRYER INTERNAL PRESSURE \_\_\_\_\_ VACUUM ONLY

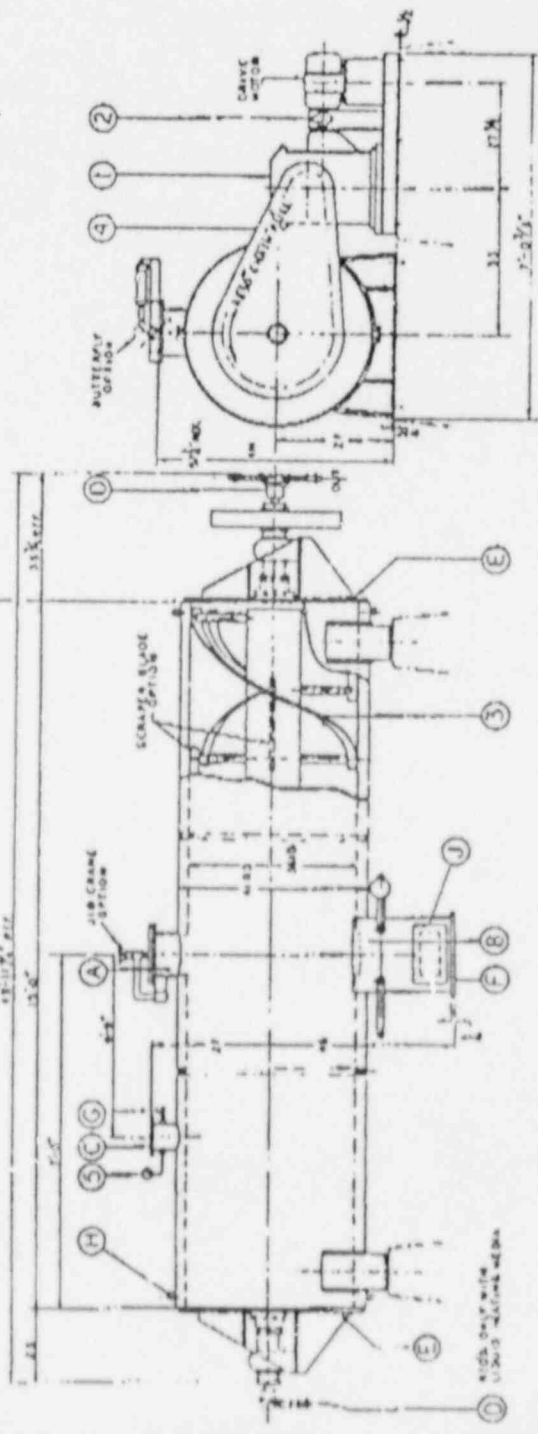
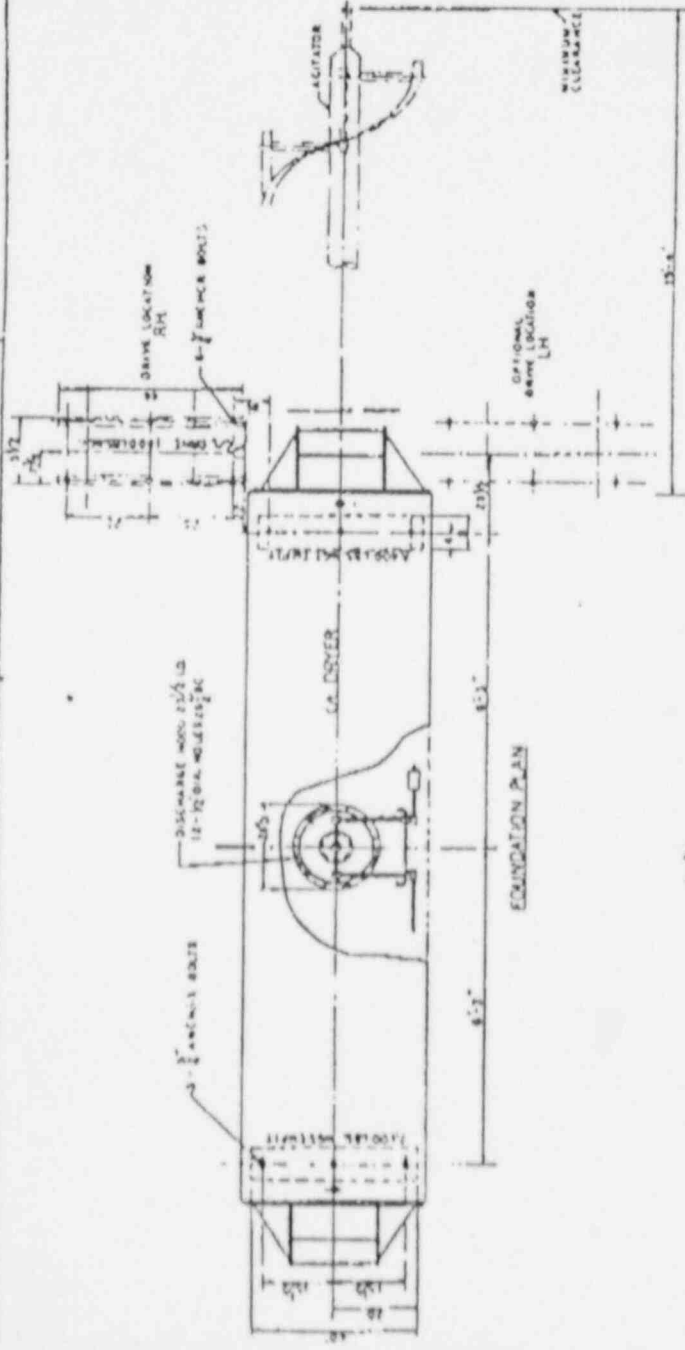
- MATERIALS OF CONSTRUCTION -  
 SIG. MILD STEEL CARBON STEEL 304L 316  
 PRODUCT SURFACES \_\_\_\_\_  
 JACKET \_\_\_\_\_  
 JACKET SEAL CHEM-N-SEAL OR OTHER RUBBER PLANTERS  
 STATIC VACUUM SEALS SILICON O-RINGS WITON  
 DRIVE MOTOR 7 1/2 HORSEPOWER 230/460 3PH 3W 1750

- FEATURE SPECIFICATION -  
 1 REDUCER MEDICAL NON TYPE  
 2 COUPLING MEDICAL TYPE  
 3 DRYER AGITATOR DOUBLE MEDICAL RETURN SPEEDS  
 4 CHAIN GUARD DIA. TIGHT FOR PLOTTED CHAIN DRIVE  
 5 VACUUM GAGE 0 TO 30 INCHES MERCURY DIAL SIZE \_\_\_\_\_

- NOZZLES & CONNECTIONS -  
 A CHARGING PORT SIZE 1/2" 150 LB. WSA  
 B DISCHARGE PORT SIZE 10" I.B. PLUG TYPE VALVE  
 C VACUUM & DUST FILTER PORT SIZE 8" 150 LB. WSA OR  
 D ROTARY JOINT SIZE \_\_\_\_\_ SUPPLIED WITH ALUMINUM METAL  
 E HANDHOLE COVER GRAVE END 6" DIA. 200 LB. END 6  
 F DISCHARGE HOOD DUST TIGHT  
 G VACUUM BREAK VALVE BALL VALVE SIZE 1" 150 LB.  
 H JACKET HEATING \_\_\_\_\_ SIZE 2" WPT  
 J ACCESS PORT

- OPTIONS -  
☐ INTERNAL SCRAPPER - SPRING LOADED  
☐ DUST FILTERS SEE DRYER NO. \_\_\_\_\_  
☐ DRIVE LOCATION RH ☐ LH  
☐ HEATING MEDIA STEAM ☐ LIQUID  
☐ CHARGING JIB CRANE ☐ BUTTERFLY VALVE

|                         |         |
|-------------------------|---------|
| TOTAL BILL OF MATERIALS |         |
| QUANTITY                | PRICE   |
| 1                       | 100.00  |
| 2                       | 200.00  |
| 3                       | 300.00  |
| 4                       | 400.00  |
| 5                       | 500.00  |
| 6                       | 600.00  |
| 7                       | 700.00  |
| 8                       | 800.00  |
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| 44                      | 4400.00 |
| 45                      | 4500.00 |
| 46                      | 4600.00 |
| 47                      | 4700.00 |
| 48                      | 4800.00 |
| 49                      | 4900.00 |
| 50                      | 5000.00 |



NOTES: ONLY WITH LIQUID HEATING MEDIA

(2) TRACE TUBING CONNECTION

1" FPT

STOKES MODEL 50-523

INVERTED DUST FILTER

25 SQ. FT.

15" TOP CONNECTION

12" BOTTOM CONNECTION

13"

22"

14"

GEAR MOTOR 1/4 HP

E.P., 120V, 60HZ, 1PH.

ELECTRICAL OPTION

WHEN NOTED

OTHER VOLTAGE

OTHER ENCLOSURE

VIBRATOR MECHANISM

210 CRANE

3" STD 150 LBS.

NOTE:

MATERIALS IN CONTACT WITH PROCESS

VAPORS & FINES AS MARKED 'X'.

CARBON STL. ☐ 80488 ☐ 31688 ☐

BASKETS NEOPRENE ☐ NORDOL ☐

SILICONE ☐ VITON ☐

73" APPROX.

65"

APPROX. WT. 500 LBS.

10" ACCESS DOOR

INFILTER BAGS

8" STD. 150 LBS.

42"

1 1/2" TYP.

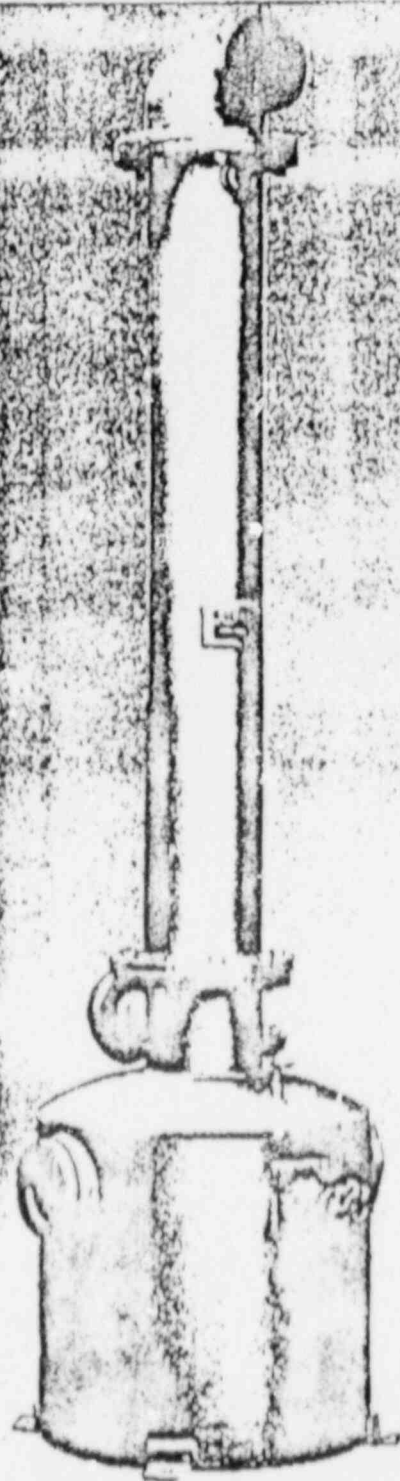
20" O.D.

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# STOKES<sup>®</sup> VERTICAL TUBE SURFACE CONDENSER AND RECEIVER

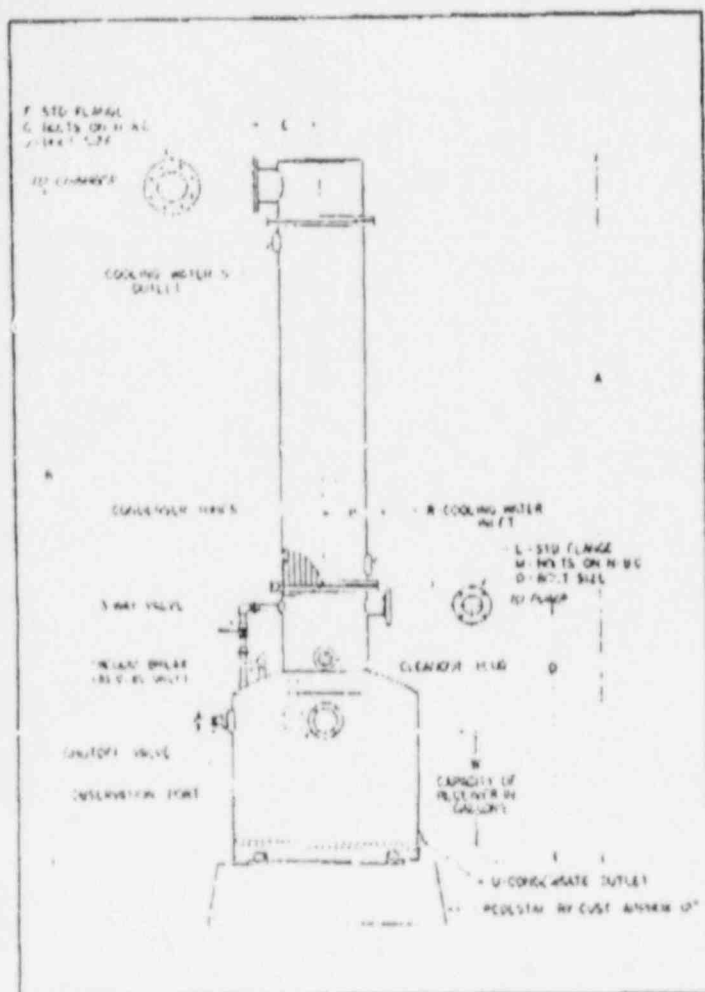
THE STOKES MODEL 311 VERTICAL TUBE surface  
condensers and receiver are built for

- Compact design—ready for floor installation
- Extra large tube diameter for minimum  
pressure drop.
- Extra large observation port on the receiver  
body.
- Welded carbon steel tube joints with threaded  
seamless brass tubes for mounting in place.
- Isolation valve for breaking vacuum and draining  
receiver without interrupting system operation.
- Vacuum tested to 1/2 torr.
- Flanged vacuum connections.



STOKES  
 **PENNWALT**  
 EQUIPMENT • CHEMICALS  
 HEATING PRODUCTS

# STOKES VERTICAL TUBE SURFACE CONDENSER AND RECEIVER

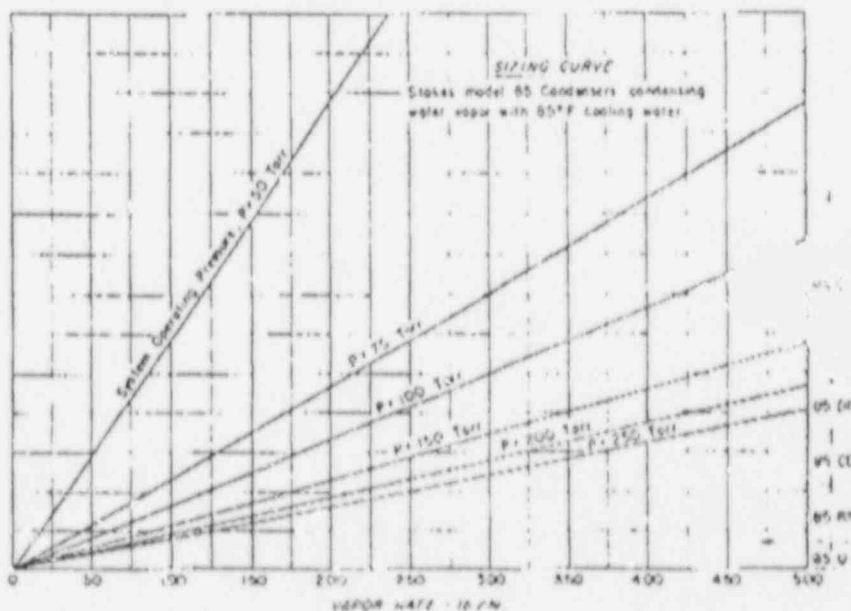


| MODEL NO.                | 85-C      | 85-BS     | 85-CD     | 85-DD      | 85-E       |
|--------------------------|-----------|-----------|-----------|------------|------------|
| Cooling Surface SQ. FT.  | 10        | 43        | 67        | 98         | 190        |
| Cooling Water GPM @ 85°F | 20        | 30        | 55        | 85         | 110        |
| Number of Tubes          | 12        | 38        | 58        | 76         | 142        |
| Tube Shell Length        | 3'-9"     | 5'-1 1/2" | 5'-1 1/2" | 5'-9 3/4"  | 5'-11 1/4" |
| Inside Dia. of Shell     | 6"        | 8"        | 11"       | 12 1/4"    | 16"        |
| A                        | 6'-9 1/2" | 8'-10"    | 9'-7 1/2" | 10'-5 1/4" | 11'-6 1/2" |
| B                        | 6'-6 1/2" | 8'-6 1/4" | 9'-3"     | 10'-0 1/4" | 11'-1"     |
| C                        | 18 1/2"   | 28 1/2"   | 33 1/2"   | 33 1/2"    | 40 3/4"    |
| D                        | 24 1/2"   | 31"       | 39 1/4"   | 39 1/4"    | 50"        |
| E                        | 6"        | 8"        | 10"       | 11"        | 13"        |
| F                        | 2"        | 3"        | 4"        | 5"         | 6"         |
| G                        | 5"        | 4"        | 8"        | 8"         | 8"         |
| H                        | 4 3/4"    | 6"        | 7 1/2"    | 8 1/2"     | 9 1/2"     |
| J                        | 5 1/2"    | 5 1/2"    | 5 1/2"    | 5 1/2"     | 5 1/2"     |
| L                        | 2"        | 2 1/2"    | 3"        | 3"         | 3"         |
| M                        | —         | 4"        | 4"        | 4"         | 4"         |
| N                        | —         | 5 1/2"    | 6"        | 6"         | 6"         |
| O                        | —         | 5 1/2"    | 5 1/2"    | 5 1/2"     | 5 1/2"     |
| P                        | 4 1/2"    | 10"       | 13 1/2"   | 13 1/2"    | 13"        |
| R-TAP N.P.T.             | 1/2"      | 1"        | 2"        | 2"         | 2 1/2"     |
| S-TAP N.P.T.             | 1/4"      | 1 1/4"    | 2 1/2"    | 2 1/2"     | 3"         |
| U-TAP N.P.T.             | 1"        | 2"        | 2"        | 2"         | 2"         |
| W Gallons                | 8 1/2     | 27        | 52        | 52         | 97         |
| Wt. Lbs.                 | 375       | 700       | 1050      | 1200       | 1850       |

## Condenser Selector Chart

How to use:

1. Determine vapor rate in pound per hour.
2. Select line indicating operating pressure of system.
3. Read right from point where vapor rate and system pressure line meet to select proper condenser size.



Stokes Division  
Pennwalt Corporation  
5500 Tabor Road  
Philadelphia, PA 19136  
(215) 831-0400

**STOKES**  
**PENNWALT**  
EQUIPMENT • CHEMICALS  
HEAT EXCHANGERS

## — Low Cost Drying of Yellow Cake —

Have you considered vacuum drying?

A Stokes vacuum drying system offers certain advantages over an open hearth dryer. These advantages are:

- Low Capital Equipment Cost
- Low Installation Cost
- Low Operating Cost
- Dust Containment
- Environmentally Protective

The approximate utilities required for an 8000 lb. load of "yellow cake" slurry containing 30% solids are as follows:

|                                      | Peak         |
|--------------------------------------|--------------|
| • Steam at 50 psig .....             | 250 lbs./hr. |
| • Cooling tower water at 85° F ..... | 50 gpm       |
| • Electric .....                     | 10 HP        |

Installation of the Stokes vacuum drying system requires only rotary dryer support, connecting vacuum piping between dust filter and vacuum skid, and utility connections.

The stationary jacketed dryer can be loaded and unloaded with ease. The "yellow cake" slurry can be pumped into the dryer; the dry product discharged directly into a suitable container via dust-tight shrouds.

In addition to its ease of installation and simplicity of operation, the Stokes system provides dust containment during drying and product discharge. The use of the condenser and the closed-loop seal fluid system permit almost total recovery of the process water.

This system is in keeping with the zero discharge concept advocated by regulatory agencies.

The heart of our system is the Stokes rotary vacuum dryer. This batch type vacuum dryer with its internally heated agitator provides excellent heat transfer. The addition of spring loaded scraper blades prevents product build-up during the drying cycle.

The auxiliary equipment includes a Stokes inverted bag type dust filter which is flange mounted on top of the dryer. The dust is collected on the inner walls of the bags. At regular intervals the bags are mechanically shaken and the dust returned to the dryer. Automatic bag shaking controls are provided.

The Stokes vacuum system is mounted on a common baseplate complete with a control panel and the interconnecting piping and wiring.

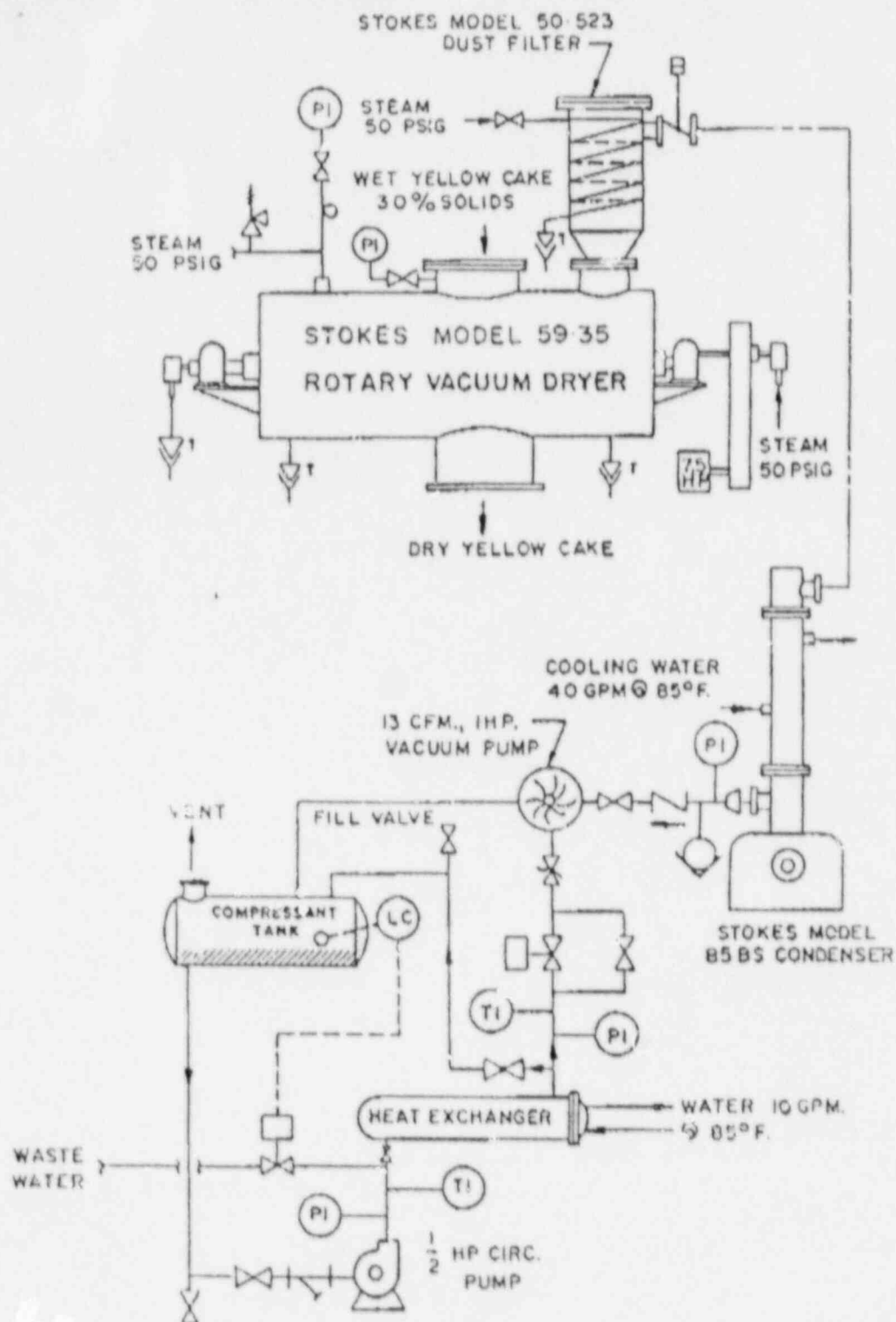
The water vapor from the dryer is condensed in a Stokes vertical tube type condenser. A solvent receiver is supplied (as an integral part of the condenser) and can be furnished with a level controller and a condensate removal pump.

The system is evacuated by a liquid ring type vacuum pump. A closed loop seal fluid system for the vacuum pump is included and consists of a circulating pump, heat exchanger and a compressant tank with a level controller.

A free standing control panel contains the required motor starter, selector switches, pilot lights and control power transformer.

Stokes is in the unique position of being the industry leader in the basic vacuum technology in addition to extensive experience in the heat and mass transfer techniques governing the drying process.

We welcome the opportunity of supplying a vacuum system for you.—



YELLOW CAKE VACUUM DRYING SYSTEM

Stokes Vacuum Components Department  
PENNWALT CORPORATION  
550 Tabor Road, Philadelphia, PA 19120  
215-289-0100

**STOKES**  
**PENNWALT**  
EQUIPMENT • CHEMICALS  
HEALTH PRODUCTS

# $U_3O_8$ PROCESS AVOIDS SULPHATES AND CHLORIDES



A special adapter developed by IEC allows an operator to wheel a 55-gal drum under the dryer outlet and raise it tightly against the discharge opening to receive a load of dried yellowcake. When the barrel is full, the discharge valve is closed and the barrel is lowered and wheeled to a weighing station.

A yellowcake precipitation process developed by Intercontinental Energy Corp. (IEC) for its Zamzow in-situ uranium leaching operations in Live Oak County, Tex., uses neither sulphates nor chlorides in extraction and precipitation. The process thereby avoids formation of uranium salts that require high-temperature calciners. IEC uses a solution of ammonium carbonate and hydrogen peroxide for leaching and live steam to sparge the pregnant eluate, driving off ammonia and carbon dioxide and precipitating yellowcake. A rotary vacuum dryer, the first to be used in such an application, accepts a yellowcake slurry containing 30% solids and produces a dry product ready for packaging.

Plant manager Kim Harden notes that the process does not require pollution control devices, such as stack filters and scrubbers, that must be installed for calciners. Utility costs for the vacuum drying system are quite low, and system components are packaged on skids that are positioned easily on concrete floors and relocated quickly to a new job site. The vacuum drying system was supplied by the Stokes Div. of Pennwalt Corp.

At Zamzow, IEC circulates leach solution through ore zones about 175 ft below ground. The solution oxidizes the uranium minerals to a form amenable to leaching by ammonium carbonate. Chemistry of the solution is controlled to prevent significant precipitation of calcium carbonate in the system. At any given time, 80 to 100 injection wells and 40 to 50 production wells are usually in operation to provide leach liquor for the plant. The wells are cased with PVC and are equipped with 3-hp to 5-hp stainless steel down-hole pumps that generate an average leachant flow of 1,050 gpm to three uranium recovery circuits. With minor exceptions, construction and completion of the wells follows conventional practices of the water well industry.

The well field operates in a balanced condition that confines leachants to the ore zones between injection and production wells. Water in a series of 4-in.-dia monitor wells surrounding the orebody is sampled biweekly to determine if any leachant is escaping from the well field.

Uranium-bearing leachant is pumped to a surface plant equipped with three parallel ion exchange circuits, each of which includes a 10,000-gal fiberglass surge tank, a 60-hp circulation pump, a series of filters to remove particulate matter, and three 7 x 8-ft down-flow resin ion exchange columns. After uranium has been extracted in the ion exchange circuits, the leachant is pumped back to the well field by 15-hp injection pumps.

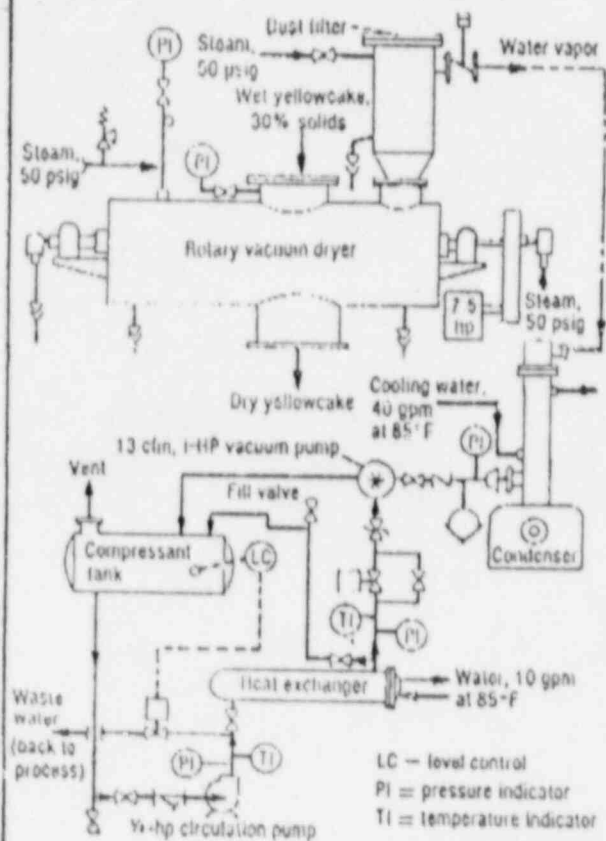
When an ion exchange column becomes loaded to capacity, it is isolated from the circuit, and a solution of ammonium carbonate is used to strip the uranium from the ion exchange resin. The resulting pregnant eluate then advances to one of three 4,000-gal stainless steel tanks.

The eluate is sparged with live steam, driving off ammonia and carbon dioxide and precipitating the uranium. Offgases are recovered, and the resulting uranium slurry is pumped to a 5,000-gal fiberglass storage tank for settling and decanting. After decantation, the slurry is pumped to the vacuum dryer.

A reverse-osmosis water treatment plant provides plant makeup water and water for the boilers. Leachants and elution solutions are prepared on the site by injecting anhydrous ammonia and carbon dioxide into water in a modified 4,000-gal stainless steel fertilizer mixer.

The rotary vacuum dryer in use at Zamzow is one of a line of Stokes units that have found a variety of applications, including installations to dry slurries of powdered metal, pharmaceuticals, herbicides, and pesticides. The near-zero

# Vacuum drying system at Zamzow mine



pollution characteristics of the system were very attractive to IEC. Because the system operates under vacuum, a leak results in air being drawn into the system, rather than contaminants being released to the atmosphere. The units are available in sizes ranging from 15 in. to 5 ft ID and from 20 in. to 30 ft internal length.

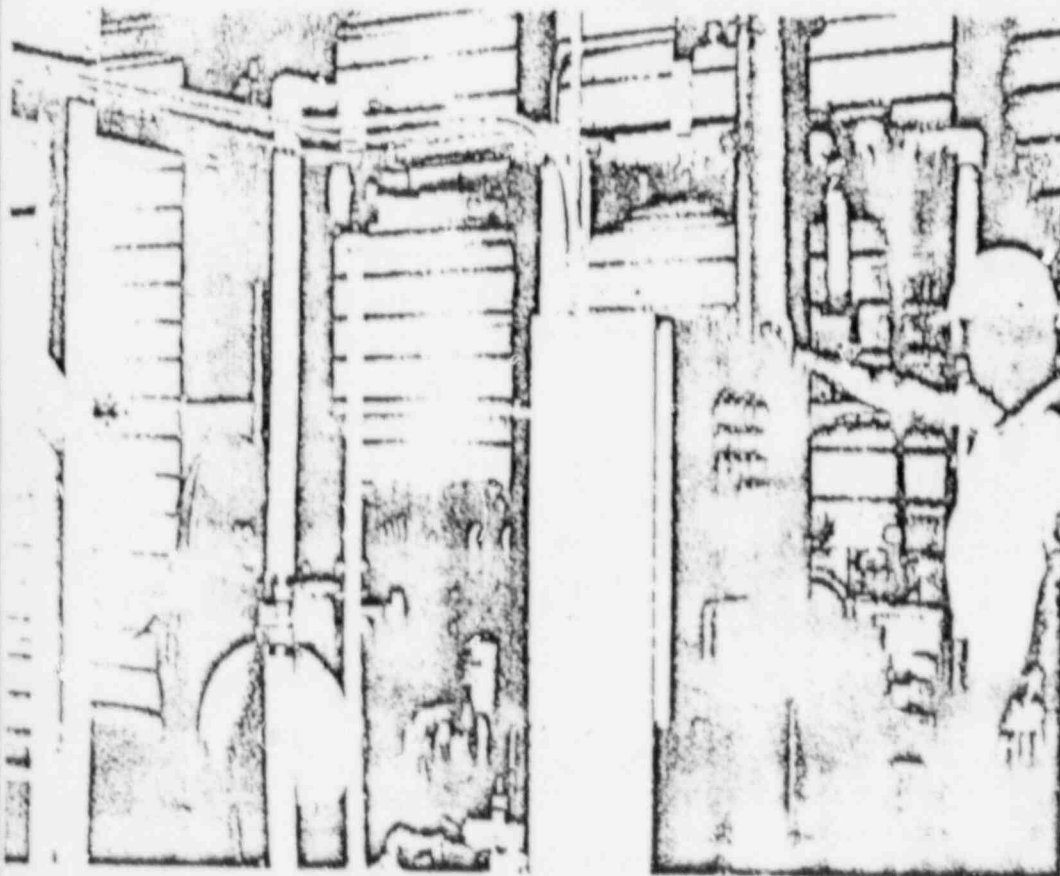
The dryer at Zamzow has an inside diameter of 3 ft and an internal length of 10 ft, providing a total volume of 70 cu ft and a capacity of 1,500 lb per day of yellowcake. It is heated by means of steam jacketing along the cylindrical container and steam inside the shaft and arms of the helical agitator. Heat transfer is aided not only by the continuous mixing action of the rotating agitator but also by spring-loaded scraper blades that prevent buildup of dried yellowcake on the inside heating surfaces.

Approximate utility requirements to process a 4,000-lb load of yellowcake slurry at 30% solids include: 250 lb per hr of steam at 50 psig, 40 gpm of condenser cooling water at 85°F, and electricity to drive a 10-hp motor.

Dried yellowcake discharges directly into 55-gal drums; the discharge valve port is fitted with a dust-tight shroud. An inverted, bag-type dust filter flange-mounted on top of the dryer prevents dust from getting into the vacuum systems. The bags are shaken mechanically at regular intervals, and dust is returned to the dryer.

Water vapor from the dryer is condensed in a vertical tube-type condenser, and the water that is recovered returns to the circuit, another significant pollution-control feature of the system. (See flowsheet.)

Zamzow, which is designed to produce 300,000 lb per year of  $U_3O_8$ , is the second in-situ leaching uranium mine developed by IBC in Texas, the first being located at Pawnee. Pacific Gas and Electric, which has contracted for the entire output of the Zamzow mine, received its first shipment of yellowcake on Aug. 1, 1978.



Dryer control panel includes motor starter, selector switches, pilot lights, and control power transformer. Vertical condenser column is at the operator's right hand. Compressant tank and vacuum pump are located behind the control panel.

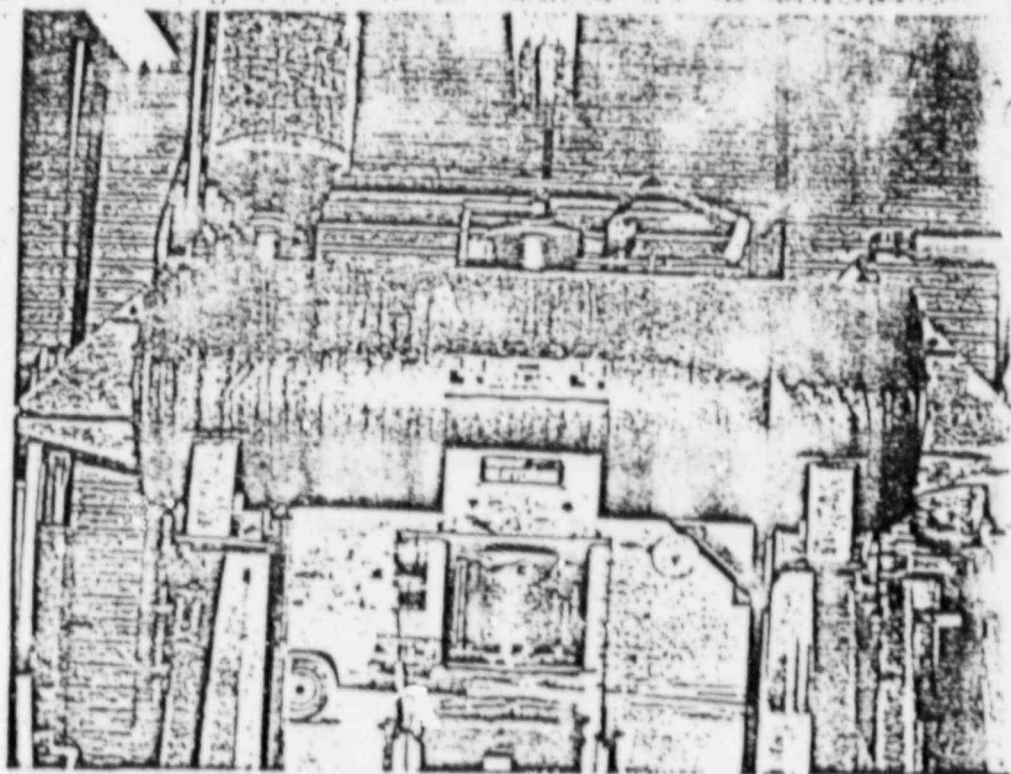
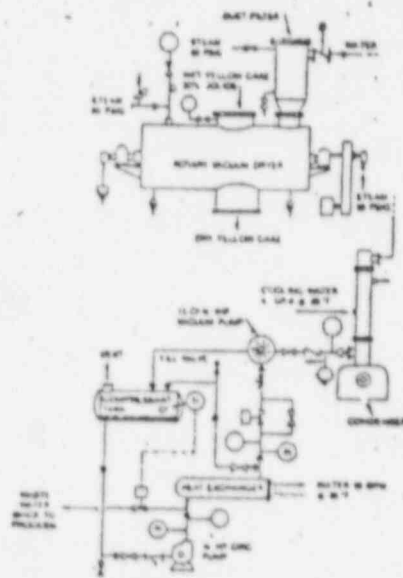
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# Rotary vacuum dryer aids "zero" pollution in uranium process

MR. RICHARD GUSTEFSON, Manager  
Zamzow Uranium Mine  
Ray Point, Tex.

JUDY MARIS, Assistant Editor

## New Solutions to Plant Problems



Rotary vacuum dryer with bottom hopper is packaged on skids

Vacuum construction, dust filter and  
wastew, ter recycling system help contain  
pollutants

A process for the extraction and precipitation of uranium oxides—yellow-cake—utilizes a rotary vacuum dryer to convert the uranium oxides solution to a dry powder. The process, now operating successfully at the Zamzow Uranium Mine in Ray Point, Texas, requires neither sulfates nor chlorides to extract or precipitate the uranium. Therefore, Zamzow is able to avoid the formation of uranium salts that require the use of high temperature calciners for dehydration. Thus, the process, utilizing a

vacuum dryer, avoids the need for pollution control equipment.

The extraction and precipitation process works like this: an ammonium carbonate and hydrogen peroxide solution is circulated through the ore zones. The uranium minerals are oxidized, then leached. The leachant is pumped to three independent ion-exchange circuits in the surface plant. Uranium is absorbed and the leachant is pumped back to the well field. When an ion-exchange column is loaded to capacity, it is isolated from

the circuit. A solution of ammonium carbonate strips the uranium from the ion-exchange resin.

The eluate containing a high concentration of uranium, is transferred to stainless steel tanks. Live steam is used to sparge the eluate, driving off ammonia and carbon dioxide and precipitating the uranium. The uranium oxides are pumped as a slurry to a storage tank for decanting. Containing 30% solids, the compounds are pumped to the vacuum dryer, capable of drying 1500 lb of

yellowcake per day.

The primary appeal of the vacuum drying system for Zamzow is its near zero pollution feature. Because it operates under vacuum, any leaks will result in air being drawn into the system rather than in the release of contaminants to the atmosphere.

The drying unit at Zamzow has an ID of 3 ft and an internal length of 10 ft, providing a total volume of 70 cu ft. It is heated by means of steam jacketing all along the cylindrical container. In addition, steam flows inside the shaft and arms of the helical agitator. Heat transfer is promoted by the continuous mixing of the rotating agitator as well as by spring-loaded scraper blades which prevent buildup of dried yellowcake on the inside heating surfaces. Dried yellowcake is discharged directly into 55-gal drums, using a dust-tight shroud around the discharge valve port.

An inverted bag-type dust filter is flange-mounted to the top of the dryer. Dust is collected on the inner walls of the bags. At regular intervals, the bags are mechanically shaken and the dust is returned to the dryer.

Water vapor from the dryer is condensed in a vertical tube-type condenser. The system is evacuated by a liquid ring-type vacuum pump which has a closed-loop seal fluid system. Wastewater from the drying process is recovered and returned for reuse.

The drying system components are packaged on skids which mount on concrete floors. They can be relocated to a new job site easily. Installation requires only rotary dryer support, interconnecting vacuum piping between the dust filter and the vacuum skid, and utility connections. The ease of installation, along with the many pollution control features, have made the dryer a vital piece of equipment at Zamzow. ■

*Vacuum drying system was supplied by Stokes Div., Penawalt Corp., 3 Parkway, Philadelphia, PA 19102.*

Circle 131 opposite last page.

*Uranium extraction/precipitation process was developed by Intercontinental Energy Corp., P.O. Box 17529, Denver, CO 80217.*

Circle 132 opposite last page.

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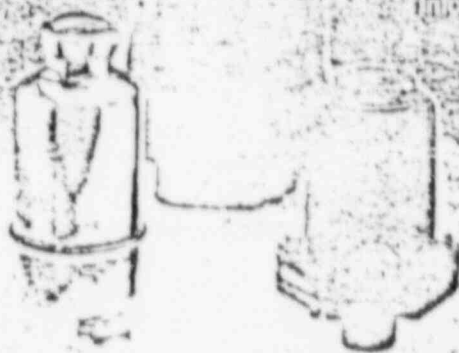
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