(COPY)

Donald I. Walker, Director, Idaho
Compliance Area, Division of Compliance

August 4, 1961

Walter B. Carlson, Assistant Manager for
Administration, Grand Junction Operations Office

PETROTOMICS COMPANY'S URANIUM MILL OPERATIONS

SYMBOL: SM:DRC

In reference to your memorandum of July 28, the Commission entered into a contract with the Petrotomics Company on August 12, 1960. This contract provides for the purchase of uranium ore only in the period prior to April 1, 1962 and for the purchase of uranium concentrates during the period April 1, 1962 - December 31, 1966.

The Petrotomics Company is a corporation formed by the following companies:

Tidewater Oil Co.
4201 Wilshire Blvd., Los Angeles 5, California

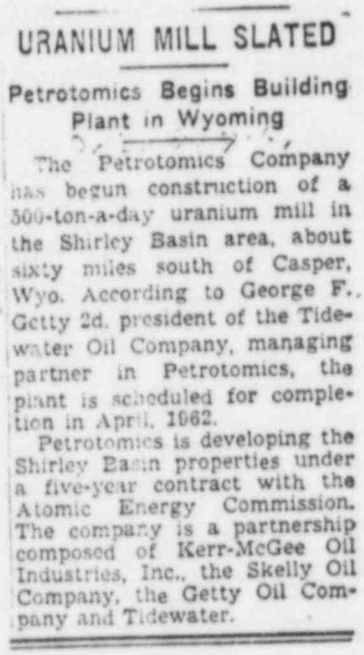
Kerr-McGee Oil Industries, Inc.
Oklahoma City, Oklahoma

Skelly Oil Co.
Tulsa, Oklahoma

Getty Oil Company
Wilmington, Delaware

Mr. Norman A. Grant, Project Manager, is in charge of wyoming operations. His address is Petrotomics Co., P. O. Box 184, Casper, Wyoming. Overall responsibility for control of the Petrotomics operation is in charge of Mr. J. P. McCabe, Production Manager, Foreign Exploration and Production Division, Tidewater Oil Co., 4201 Wilshire Boulevard, Los Angeles 5, California.

NEW YORK TIMES SEPT. 7, 1961



URANIUM MILL SLATED

Petrotomics Begins Building Plant in Wyoming

The Petrotomics Company has begun construction of a 500-ton-a-day uranium mill in the Shirley Basin area, about sixty miles south of Casper, Wyo. According to George F. Getty 2d, president of the Tidewater Oil Company, managing partner in Petrotomics, the plant is scheduled for completion in April, 1962.

Petrotomics is developing the Shirley Basin properties under a five-year contract with the Atomic Energy Commission. The company is a partnership composed of Kerr-McGee Oil Industries, Inc., the Skelly Oil Company, the Getty Oil Company and Tidewater.

Meteorological Data F. The Current Year

Station CASPER, WYOMING NATRONA COUNTY INTL AIRPORT
Standard time used MOUNTAIN
Latitude 42 55 N
Longitude 106 28 W
Elevation (ground) 5338 feet
Year 1975

Month	Temp. °F Averages Daily maximum	Daily minimum	Monthly	Extremes Highest	Date	Lowest	Date	Degree days Base 65 °F Heating	Cooling	Precip. Water equivalent Total	Greatest in 24 hrs.	Date	Snow, Ice pellets Total	Greatest in 24 hrs.	Date	Relative humidity pct. Hour 05	Hour 11	Hour 17	Hour 23	Wind Resultant Direction	Resultant Speed m.p.h.	Average speed m.p.h.	Fastest mile Speed m.p.h.	Direction	Date	Percent of possible sunshine	Average sky cover tenths, sunrise to sunset	Number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility 1/4 mile or less	Temperature °F Maximum 90° and above (b)	Maximum 32° and below	Minimum 32° and below	Minimum 0° and below	Average station pressure mb. Elev. 5290 feet m.s.l.
JAN	30.9	11.7	21.3	49	18	-16	11	1332	0	0.51	0.14	27-28	10.3	2.4	27-28	71	62	63	70	23	12.3	16.4	56	22	17		7.3	2	12	17	14	3	0	1	0	18	31	6	833.7
FEB	31.0	10.7	20.9	48	28	-13	9	1230	0	0.51	0.32	14-15	8.1	3.7	14-15	74	64	62	71	23	11.4	16.0	58	22	20		6.4	9	5	14	8	3	0	0	0	12	27	7	834.1
MAR	40.6	19.4	30.2	61	19	-2	12	1064	0	2.01	0.56	22-23	38.2	6.8	26-27	76	63	56	75	29	5.2	14.1	55	24	19		7.6	3	8	20	12	9	1	1	0	8	29	5	833.7
APR	48.7	26.7	37.7	75	25	-2	2	813	0	0.97	0.44	7	13.4	6.3	7	77	53	48	70	26	5.2	12.9	56	19	25		7.3	5	7	18	8	3	3	2	0	4	27	2	837.0
MAY	61.4	36.3	48.9	82	16	24	1	493	0	3.88	1.60	19-20	21.3	12.3	19-20	77	45	41	70	25	5.3	12.4	44	23	24		7.2	3	10	18	14	5	5	1	0	1	8	0	836.4
JUN	73.9	44.1	59.0	89	30	36	11	193	16	0.94	0.26	17-18	0.0	0.0		82	38	37	67	25	5.4	11.8	52	35	18		5.7	9	9	12	10	0	8	0	0	0	0	0	836.1
JUL	88.9	57.2	72.9	95	28	45	12	1	294	0.63	0.37	3	0.0	0.0		71	35	28	56	25	3.8	10.4	52	20	3		4.4	10	18	3	13	0	13	0	12	0	0	0	840.2
AUG	85.0	51.0	68.0	94	7	40	26	18	119	0.17	0.08	13	0.0	0.0		60	25	21	43	25	6.8	11.9	35	24	23		4.0	15	10	6	3	0	4	1	6	0	0	0	839.5
SEP	74.6	38.9	56.7	90	1	26	22	247	3	0.11	0.08	17-18	T	T	18	60	31	22	52	27	3.4	9.5	30	22	17		2.3	22	6	2	4	0	0	1	1	0	2	0	842.2
OCT	62.7	33.0	47.6	84	8	16	23	537	1	1.01	0.55	26-27	11.9	6.8	27	63	43	35	54	24	9.7	13.7	35	21	25		5.8	9	12	10	6	2	0	3	0	2	16	0	838.4
NOV	44.4	20.5	32.5	69	4	-14	30	969	0	0.31	0.28	27-28	6.6	3.7	27-28	64	47	46	61	24	9.8	14.8	40	23	30		5.4	11	7	12	8	2	0	1	0	9	22	5	836.1
DEC	37.7	19.1	28.4	57	4	-11	17	1126	0	0.72	0.32	13	14.1	5.1	13	73	64	64	71	22	11.9	16.7	57	22	4		5.9	10	9	12	8	3	0	2	0	11	27	3	837.1
YEAR	56.9	30.8	43.7	95	JUL 28	-16	JAN 11	8040	395	11.92	1.60	MAY 19-20	124.0	12.3	MAY 19-20	71	48	44	63	24	7.4	13.3	58	23	MAY 24		5.8	108	113	144	110	30	34	13	19	65	184	28	836.0

Normals, Means, And Extremes

Month	Temperatures °F Normal Daily maximum	Daily minimum	Monthly	Extremes Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F Heating	Cooling	Precipitation in inches Water equivalent Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Ice pellets Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity pct. Hour 05	Hour 11	Hour 17	Hour 23	Wind Mean speed m.p.h.	Prevailing direction	Fastest mile Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility 1/4 mile or less	Temperatures °F Max. 90° and above (b)	Max. 32° and below	Min. 32° and below	Min. 0° and below	Average station pressure mb. Elev. 5290 feet m.s.l.
(a)				11		11					35		45		25		25		25		11	11	11	11	25	13	22	22			25	25	25	25	25	25	25	25	11	11	11	11	3
J	33.6	12.7	23.2	60	1971	-40	1972	1296	0	0.50	0.99	1972	T	1952	0.39	1972	19.2	1972	9.7	1972	68	59	61	68	17.0	SW	58	20	1954		6.7	7	7	17	7	3	0	1	0	13	29	6	834.3
F	37.7	15.9	26.8	61	1972	-17	1972	1070	0	0.50	1.01	1955	0.15	1957	0.40	1956	23.8	1952	10.4	1952	70	58	57	70	15.3	SW	58	23	1957		6.5	7	7	14	8	3	*	1	0	9	27	3	835.4
M	42.6	19.4	31.0	73	1966	-21	1965	1054	0	0.91	2.43	1954	0.25	1953	1.00	1958	36.2	1975	14.0	1954	72	54	49	70	14.2	SW	61	25	1956		6.7	6	9	16	9	4	*	1	0	6	27	3	831.4
A	55.5	29.9	42.7	80	1969	-4	1966	669	0	1.45	3.92	1974	0.20	1952	3.00	1974	56.3	1973	16.5	1973	76	56	45	71	13.0	WSW	54	25	1967		6.8	6	9	15	10	4	1	2	0	1	21	*	833.7
M	66.1	39.3	52.7	91	1969	17	1968	388	6	1.94	5.59	1971	0.30	1966	2.07	1952	23.9	1950	14.1	1950	77	44	39	68	11.8	WSW	58	32	1959		6.6	6	10	15	10	1	6	1	*	*	8	0	835.2
J	76.3	47.4	61.9	101	1970	26	1969	147	94	1.44	3.75	1967	0.03	1956	1.67	1969	3.0	1969	3.0	1969	78	40	35	65	11.2	WSW	52	36	1959		5.2	10	11	9	9	*	8	1	3	0	1	0	836.7
J	87.1	54.9	71.0	99	1973	36	1972	13	199	0.95	3.05	1951	0.11	1971	1.33	1951	0.0		0.0		71	32	26	54	10.1	WSW	42	25	1974		4.0	15	11	5	9	0	9	*	11	0	*	0	840.1
A	85.6	53.5	69.6	99	1969	33	1965	17	159	0.57	1.57	1972	0.02	1950	1.00	1974	T	1964	T	1964	65	30	23	51	10.5	SW	50	23	1954		4.2	15	9	7	5	0	6	*	10	0	0	0	839.3
S	74.1	43.3	58.7	91	1969	19	1965	229	40	0.87	3.28	1973	0.07	1956	2.01	1973	6.8	1965	4.5	1965	68	37	31	60	11.1	WSW	53	32	1965		4.4	14	8	8	7	*	3	1	1	*	5	0	841.0
O	61.4	33.9	47.7	84	1975	-3	1971	536	0	0.92	2.49	1962	T	1965	2.49	1962	13.1	1971	8.2	1970	68	44	41	63	12.4	SW	55	25	1956		5.2	12	8	11	6	2	*	1	0	1	16	*	838.1
N	44.8	22.9	33.9	71	1965	-14	1975	933	0	0.68	1.30	1956	0.07	1965	0.54	1955	19.9	1956	9.7	1956	69	54	56	67	14.8	SW	49	25	1970		6.3	7	9	14	7	3	*	1	0	5	25	2	836.0
D	36.2	16.2	26.2	61	1973	-31	1964	1203	0	0.49	1.04	1955	0.03	1952	0.47	1970	17.8	1967	8.2	1951	69	59	62	68	16.2	SW	63	20	1955		6.3	8	8	15	7	3	0	1	0	14	29	5	835.9
YR	58.4	32.4	45.4	101	JUN 1970	-40	JAN 1972	7555	458	11.22	5.59	MAY 1971	T	OCT 1965	3.00	APR 1974	56.3	APR 1973	16.5	APR 1973	71	47	44	65	13.1	SW	81	25	MAR 1954		5.7	113	106	146	92	23	34	9	24	30	187	19	836.5

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 104 in July 1954; maximum monthly precipitation 5.75 in April 1941; maximum precipitation in 24 hours 3.09 in April 1941; maximum monthly snowfall 39.3 in January 1949; maximum snowfall in 24 hours 20.6 in May 1946.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

A/1

Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1940	19.3	29.2	37.4	42.2	51.4	60.4	74.7	70.4	60.3	52.7	27.8	28.8	47.3
1941	25.5	37.6	31.4	47.7	58.2	62.4	71.4	69.8	56.8	46.3	39.2	29.2	46.3
1942	21.5	19.7	37.4	47.8	45.6	61.0	71.2	69.8	56.6	46.9	34.2	29.8	44.8
1943	29.7	32.0	25.9	53.1	48.2	62.3	71.8	71.8	55.6	49.1	35.4	27.6	46.3
1944	23.2	24.1	29.8	41.6	51.0	57.4	68.0	66.8	57.4	37.8	32.2	24.0	44.1
1945	26.5	25.6	36.2	36.9	51.1	55.1	70.1	69.2	56.2	37.4	38.3	24.3	44.4
1946	27.4	29.3	39.6	52.6	47.2	62.1	71.8	65.0	58.2	41.9	39.1	33.0	46.9
1947	25.5	21.6	37.1	47.8	52.1	58.4	71.3	71.0	61.0	52.1	25.1	20.8	44.6
*1948	22.5	27.3	27.6	45.2	56.4	62.5	72.5	69.7	63.5	44.4	25.4	21.6	44.3
1949	9.7	27.4	35.7	48.5	53.2	60.6	70.6	69.7	57.1	41.0	42.7	24.4	43.8
*1950	17.7	32.8	27.9	45.7	48.2	60.4	64.7	65.6	58.2	52.3	33.8	31.2	44.6
1951	23.5	29.6	28.7	37.9	53.7	59.3	69.4	68.0	55.3	46.3	35.5	22.4	43.1
1952	25.8	25.8	27.7	47.1	53.7	65.2	70.1	70.2	63.7	49.6	25.1	29.2	46.3
1953	32.7	24.9	35.4	39.4	48.6	55.5	73.5	70.8	62.2	51.7	39.2	24.7	47.3
1954	27.1	37.5	27.2	48.9	53.2	63.1	76.1	71.1	62.5	46.2	47.2	29.8	46.3
1955	22.3	27.3	29.4	43.3	54.8	62.4	73.2	73.2	60.5	37.4	29.0	27.2	44.9
1956	27.4	24.1	35.2	42.7	55.5	67.3	70.8	67.0	61.7	47.9	29.8	28.4	46.4
1957	16.2	37.1	34.7	38.7	51.6	61.3	71.8	71.1	54.2	48.4	29.3	31.8	45.1
*1958	28.3	31.3	29.4	40.3	59.5	67.7	67.3	71.5	63.1	48.7	34.2	27.1	46.8
1959	29.7	23.0	37.6	42.0	53.5	65.8	70.5	70.6	56.2	43.7	37.8	30.4	45.0
1960	22.1	19.3	33.3	44.2	53.6	61.7	71.4	67.3	60.7	47.5	33.7	25.5	45.1
1961	29.7	31.4	37.0	41.0	54.4	66.1	70.3	72.1	51.4	44.8	32.3	21.8	45.7
1962	15.4	26.8	32.4	46.7	56.5	61.5	67.8	67.7	58.4	51.3	38.4	27.4	45.4
1963	13.7	27.6	36.4	42.4	55.2	64.9	72.0	70.4	64.1	54.5	39.3	24.9	47.3
*1964	23.2	21.2	29.1	39.7	54.1	61.1	74.1	66.1	56.1	47.1	31.3	23.4	45.3
1965	29.7	22.0	25.5	43.9	49.9	62.1	69.3	69.3	47.9	51.8	39.8	29.1	44.4
1966	21.8	24.3	37.7	38.9	57.5	61.6	74.9	65.8	62.2	45.2	35.1	22.3	45.8
1967	26.7	27.7	38.6	42.7	49.1	59.5	65.8	69.0	61.0	49.2	37.8	17.5	44.8
1968	23.2	30.7	38.7	39.6	46.1	63.5	69.1	64.9	58.5	47.9	32.0	20.8	43.8
1969	27.1	25.0	28.6	46.7	55.4	57.0	71.6	71.8	63.3	37.9	36.6	25.2	43.9
1970	23.3	32.7	27.9	38.2	53.5	62.8	71.2	72.3	56.7	41.2	36.9	25.2	44.8
1971	25.5	24.7	31.9	40.9	52.1	64.3	67.2	71.2	53.9	42.8	32.9	22.9	43.9
1972	17.7	28.5	38.2	43.0	52.1	63.0	65.9	69.0	55.7	44.1	32.8	17.7	44.0
1973	19.2	24.3	37.0	36.1	51.1	63.0	68.4	70.7	55.5	46.7	33.1	26.7	44.1
1974	19.7	27.8	34.2	47.1	51.4	64.9	72.6	66.6	54.6	49.5	34.3	24.3	45.3
1975	21.1	20.9	33.2	37.7	46.9	58.8	72.9	69.0	54.7	47.6	32.9	28.4	43.7
RECORD MEAN	22.8	28.6	31.8	42.3	52.6	62.1	70.7	69.2	59.1	47.6	37.6	28.2	45.3
MAX	33.5	37.2	47.2	54.7	65.8	70.3	86.7	83.1	73.4	87.9	44.2	35.9	58.1
MIN	12.5	16.0	20.2	29.8	39.0	47.4	54.7	53.3	42.8	33.9	22.8	19.5	32.6

Heating Degree Days

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1955-56	11	3	190	467	1167	1163	1281	1177	979	723	279	23	7754
1956-57	7	19	139	464	1069	1171	1516	815	974	744	428	133	7423
1957-58	8	14	271	577	1043	1241	1128	860	1119	733	407	68	7508
*1958-59	37	11	193	469	924	1148	1073	1156	844	684	441	67	7363
1959-60	23	12	312	674	1028	1228	1321	1362	978	615	346	45	7779
1960-61	11	61	175	337	891	1266	1112	926	813	714	331	71	6876
1961-62	24	5	308	627	1033	1341	1537	1171	1072	544	328	129	8119
1962-63	19	39	144	417	748	1068	1591	921	929	672	312	34	6932
1963-64	3	6	96	326	765	1219	1298	1254	1231	751	348	135	7409
*1964-65	0	104	278	547	1004	1263	1224	1181	1377	569	463	149	8024
1965-66	6	40	312	407	749	1136	1334	1132	887	773	499	161	7381
1966-67	0	47	122	608	862	1225	1171	1037	818	854	498	147	7379
1967-68	6	22	149	514	1017	1470	1615	959	818	790	518	109	7983
1968-69	30	81	454	927	984	1426	1174	944	1147	541	224	132	7878
1969-70	3	3	71	834	914	1125	1284	887	1149	797	355	145	7590
1970-71	7	3	372	735	894	1227	1272	1119	1028	714	458	91	7982
1971-72	16	5	352	681	1276	1268	1471	1122	824	657	342	67	7794
1972-73	67	42	299	841	1025	1451	1415	1124	894	861	429	77	8512
1973-74	16	3	296	459	951	1181	1412	1044	815	630	418	15	7431
1974-75	3	61	319	926	912	1233	1374	1233	1036	818	493	181	8199
1975-76	1	19	247	537	969	1126							

Cooling Degree Days

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1969	0	0	0	0	12	18	212	221	28	0	0	0	491
1970	0	0	0	0	0	77	200	234	24	0	0	0	535
1971	0	0	0	0	0	58	229	212	26	0	0	0	395
1972	0	0	0	0	0	34	201	142	7	0	0	0	404
1973	0	0	0	0	1	63	147	182	5	0	0	0	420
1974	0	0	0	0	0	109	243	47	7	0	0	0	406
1975	0	0	0	0	0	18	254	118	5	1	0	0	395

Precipitation

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1940	0.50	0.61	0.39	1.90	1.11	0.17	0.67	0.85	1.41	0.24	0.86	0.31	8.96
1941	0.47	0.06	1.29	3.75	1.25	0.36	0.99	2.79	0.42	1.39	0.49	0.79	14.26
1942	0.14	0.43	0.16	0.95	2.74	0.29	0.37	0.32	0.36	1.99	1.93	0.37	9.88
*1943	0.83	0.28	1.16	1.00	1.79	0.56	0.29	0.09	0.84	1.37	0.53	0.51	8.91
1944	1.33	0.31	1.49	0.38	2.78	1.27	1.16	T	1.29	0.35	0.81	0.30	11.67
1945	0.25	0.49	0.88	1.24	1.07	2.46	0.60	1.17	1.39	0.27	0.28	0.79	10.92
1946	0.43	0.37	0.99	0.72	3.73	1.28	1.22	0.56	1.49	1.29	0.41	0.42	12.99
1947	0.44	0.81	0.25	2.35	2.57	3.11	1.93	0.71	0.36	0.58	1.51	1.39	15.40
*1948	0.43	0.08	0.43	1.25	1.33	2.30	0.95	0.23	0.67	1.16	0.70	0.34	10.59
1949	1.36	0.29	0.68	0.88	2.37	0.75	0.77	0.46	0.05	2.30	0.04	1.48	10.88
*1950	0.36	0.30	0.93	2.16	1.17	1.80	0.88	0.02	3.11	0.74	0.37	0.26	12.75
1951	0.27	0.16	0.44	1.21	1.45	1.35	3.05	0.13	1.12	0.88	1.25	0.42	10.93
1952	T	0.75	1.34	0.27	3.93	1.05	0.38	0.61	0.29	0.49	0.37	0.33	10.00
1953	0.53	1.00	0.25	0.96	1.80	1.37	1.52	0.95	0.11	0.16	0.72	0.74	9.72
1954	0.45	0.37	2.43	0.30	0.70	0.82	0.38	0.29	0.23	1.36	0.21	0.32	7.70
1955	0.34	1.01	0.99	1.44	0.73	2.07	0.27	0.61	0.65	0.47	1.19	1.04	11.20
1956	0.44	0.45	0.71	1.58	1.57	3.08	0.74	0.77	0.07	0.28	1.30	0.35	8.93
1957	0.42	0.15	0.91	2.45	3.65	1.93	1.00	1.13	1.09	2.05	0.77	0.43	16.12
*1958	0.11	0.38	2.27	1.95	0.78	1.32	0.95	1.00	0.34	0.02	1.06	0.21	10.42
1959	0.58	0.61	1.32	0.74	1.49	1.79	0.27	0.23	1.99	0.71	0.27	0.25	10.75
1960	0.71	0.65	0.42	1.06	0.36	0.40	0.39	0.37	0.41	0.27	1.05	0.47	7.36
1961	0.04	0.91	1.16	0.45	0.71	2.56	1.21	0.08	2.49	1.12	0.36	0.42	9.95
1962	0.85	0.44	0.15	0.93	3.43	1.75	1.26	0.25	1.16	2.49	0.36	0.23	14.01
1963	0.38	0.49	0.35	2.07	0.82	0.96	1.27	0.39	0.33	0.35	0.31	0.31	7.92
1964	0.75	0.72	0.68	1.05	2.17	1.59	0.73	0.47	0.34	0.25	0.65	0.49	10.88
1965	0.78	0.37	0.32	0.96	2.66	2.47	1.16	0.21	2.07	T	0.07	0.87	12.12
1966	0.37	0.43	0.49	1.29	0.30	1.12	0.48	1.03	0.39	1.35	0.43	0.37	8.14
1967	0.38	0.05	0.05	1.26	1.62	3.75	1.48	0.41	1.67	1.37	1.04	1.82	15.32
1968	0.33	0.48	0.92	1.19	3.33	1.66	1.02	2.61	0.33	0.59	1.56	0.71	11.88
1969	0.36	0.35	1.16	1.57	0.85	2.39	0.70	0.76	0.13	1.43	0.91	0.16	10.68
1970	0.59	0.27	1.37	1.57	2.23	2.03	0.79	0.16	0.21	1.01	1.01	0.98	12.03
1971	0.19	0.60	1.17	2.42	5.39	0.17	0.11	0.11	0.76	1.73	0.81	0.36	14.96
1972	0.99	0.61	1.41	1.44	0.76	0.83	1.06	1.32	0.37	2.26	2.96	0.41	11.81
1973	0.67	0.57	0.33	3.86	1.12	0.66	2.25	0.34	3.24	0.63	0.60	0.33	15.09
1974	0.69	0.44	0.37	3.92	0.62	0.60	0.77	1.00	0.65	1.13	0.46	0.22	11.03
1975	0.51	0.51	2.01	0.97	3.88	0.94	0.63	0.12	0.11	1.01	0.31	0.72	11.92
RECORD MEAN	0.51	0.51	0.93	1.67	1.97	1.29	0.94	0.59	0.91	0.95	0.87	0.48	11.37

Snowfall

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1939-40							9.4	9.3	3.0	9.2	0.0	0.0	
1940-41	0.0	0.0	0.0	0.3	9.8	6.1	7.4	1.1	12.0	21.3	T	0.0	58.2
1941-42	0.0	0.0	T	0.8	3.5	2.9	2.4	5.4	1.6	2.7	7.8	0.0	33.6
1942-43	0.0	0.0	0.3	5.4	19.2	2.3	8.4	3.3	11.3	T	4.1	0.0	54.4
1943-44	0.0	0.0	0.0	0.6	5.0	4.9	11.3	5.2	13.9	1.1	3.1	0.0	49.3
1944-45	0.0	0.0	4.1	0.9	8.3	7.0	4.4	8.2	10.2	21.9	2.4	T	65.3
1945-46	0.0	0.0	3.7	6.7	7.7	13.4	7.3	7.6	7.6	9.8	32.8	0.0	90.8
1946-47	0.0	0.0	1.8	6.6	8.3	3.9	8.6	13.2	5.0	17.5	4.7	4.3	74.1
1947-48	0.0	0.0	0.6	9.8	23.8	7.5	10.1	14.5	11.2	0.9	1.3	0.0	77.9
1948-49	0.0	0.0	0.0	3.5	14.6	8.1	35.3	8.0	10.2	T	T	0.0	87.8
*1949-50	0.0	0.0	1.0	22.1	T	10.1	12.2	3.6	12.7	20.8	23.6	T	134.2
1950-51	0.0	0.0	0.8	7.9	7.1	5.9	6.2	3.4	13.2	9.1	T	1.5	54.9
1951-52	0.0	0.0	3.3	6.7	4.5	12.9	0.3	23.6	29.7	2.7	2.9	0.0	87.4
1952-53	0.0	0.0	2.0	5.1	13.7	1.5	11.8	8.5	3.2	10.5	2.8	2.0	65.9
1953-54	0.0	0.0	0.0	T	5.4	14.7	9.6	8.6	32.9	1.7	0.6	T	71.8
1954-55	0.0	0.0	T	8.0	3.8	5.5	13.2	21.3	17.9	15.3	T	0.0	85.2
1955-56	0.0	0.0	T	4.2	16.7	14.5	9.0	9.9	11.3	13.6	3.8	0.0	83.0
1956-57	0.0	0.0	0.0	1.4	19.9	7.9	10.3	1.5	13.1	21.4	T	0.0	75.3
1957-58	0.0	0.0	T	1.7	10.5	6.6	1.4	7.3	25.4	21.5	0.0	0.0	74.4
*1958-59	0.0	0.0	T	T	12.2	4.3	1.6	13.8	22.1	8.9	1.1	0.0	71.0
1959-60	0.0	0.0	1.2	4.1	4.4	4.8	13.8	1.9	3.1	9.7	T	0.0	52.0
1960-61	0.0	0.0	0.0	1.6	17.3	8.4	1.6	7.7	8.3	4.8	0.0	0.0	49.9
1961-62	0.0	0.0	4.3	5.3	7.0	11.7	16.2	9.7	8.0	1.1	0.0	T	63.3
1962-63	0.0	0.0	0.2	0.0	4.5	3.2	10.6	3.6	5.0	10.1	0.0	0.0	37.2
1963-64	0.0	0.0	0.0	1.4	1.2	9.1	13.2	12.7	12.8	22.8	T	0.0	69.2
1964-65	0.0	T	0.0	T	12.9	6.7	14.3	8.6	11.4	7.3	9.1	0.0	70.3
1965-66	0.0	0.0	0.0	0.0	0.5	10.0	3.3	9.2	9.2	17.0	2.1	1.0	52.3
1966-67	0.0	0.0	T	11.9	8.0	11.8	9.2	15.6	8.5	7.3	15.2	0.0	78.0
1967-68	0.0	0.0	0.0	4.5	13.1	17.8	3.2	5.0	13.3	14.5	3.4	T	74.6
1968-69	0.0	0.0	T	0.7	4.9	18.4	2.0	0.9	13.1	12.1	T	1.0	53.1
1969-70	0.0	0.0	0.0	12.9	12.0	2.7	5.0	4.8	22.7	10.9	1.7	T	72.7
1970-71	0.0	0.0	0.2	11.2	7.4	11.9	3.7	11.2	14.8	24.2	2.2	0.0	86.8
1971-72	0.0	0.0	2.8	13.1	9.7	4.7	15.2	7.2	14.3	13.9	0.0	0.0	81.1
1972-73	0.0	0.0	0.2	9.8	8.1	9.1	9.8	11.3	10.7	56.3	1.7	0.0	116.8
1973-74	0.0	0.0	T	5.9	13.2	9.8	14.0	8.1	7.3	19.6	2.3	0.0	79.7
1974-75	0.0	0.0	5.1	1.2	8.9	5.1	10.3	8.1	30.2	13.6	21.3	0.0	109.6
1975-76	0.0	0.0	T	11.9	8.8	10.1							
RECORD MEAN	0.0	T	1.0	4.9	9.1	8.9	9.2	9.5	14.8	14.0	4.5	0.3	76.2

* Indicates a station move or relocation of instruments. See Station Location table.

Record mean values above are means through the current year for the period beginning in 1940 for temperature and precipitation, 1939 for snowfall.

STATION LOCATION

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude North	Longitude West	Elevation above Sea level: Ground at temperature site	Elevation above Ground: Wind instruments	Extreme thermometers	Psychrometer	Telepsychrometer	Tipping bucket rain gage	Weighing rain gage	8" rain gage	Hygrothermometer	Elevation above Sea level: Pyranometer	Remarks
AIRPORT																
Inland Air Lines Hangar Wardwell Field 3 miles NNW of P. O.	3/07/37	12/15/39		42° 55'	106° [illegible]	*										[illegible]
Hangar, Wardwell Field 3 miles NNW of P. O.	12/15/39	9/13/48	Approximate 150 ft. SW	42° 55'	106° [illegible]	5287	[illegible]	[illegible]	13			a30	[illegible]			First Order Station. a = Added [illegible]
Hangar, Wardwell Field 3 miles NNW of P. O.	9/13/48	3/08/50	Approximate 200 ft. ENE	42° 55'	106° [illegible]	5287	[illegible]	5	5			4	3			
Terminal Building Casper Air Terminal 8 miles NNW of P. O.	3/08/50	11/12/58	5-1/2 miles W	42° 55'	106° [illegible]	5322	[illegible]	6	5			b5	3			b = 4 feet to 3/20/52.
New WB-FAA Building Casper Air Terminal * * Natrona County International Airport effective Jan. 1973.	11/12/58	Present	1/2 mile SW	42° 55'	106° 28'	e5338	c20	[illegible]	f[illegible]			5	4	d5		c = 33 feet to 8/12/64. d = Commissioned [illegible] feet N. of thermometer site 9/[illegible] e = 5319 feet to [illegible] 64. f = Standby status after 9/[illegible] 64.

Requests for additional climatic information should be addressed to: Director, National Climatic Center, Federal Building, Asheville, N. C. 28801

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Thomas D. Potter,
Director, National Climatic Center

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Point of entry of drainage below tailings pond area into live stream

Drainage below Petrotomics Company tailings dam.

Approximate Scale:
1" = ½ Mile

Figure 6

A/2

FOR YOUR ENGINEERING NOTEBOOK

FILE NO. BULLETIN NO. M4-B136

SUBJECT URANIUM
Solvent Extraction
1,000 Tons/24 Hrs.

ETROTOMICS COMPA

Shirley Basin, Wyoming

By ELMER J. GARBELLA, E. Met., P. E.
Denver Equipment Company Division, Joy Manufacturing Company

View of the expanded Petrotomics Company Uranium Plant at Shirley Basin, Wyoming. The crushing plant is at the extreme left. Three new 80' diameter DENVER Thickeners and the original installation of six 55' diameter DENVER Thickeners are in the center of the photo. The solvent extraction building is at the far right.

Introduction

Exploration for uranium ore in the Shirley Basin of Wyoming started early in 1957, and disclosed substantial ore reserves warranting mining and milling operations. The Petrotomics Company was formed as a partnership between the Tidewater Oil Company, Kerr-McGee Oil Industries, Skelly Oil Company and Getty Oil Company, with Tidewater as the operating partner. In 1967 Tidewater and Getty amalgamated, so that now Getty Oil Company is the managing partner.

ELMER J. GARBELLA

On April 5, 1962, a newly constructed 500-ton per day acid leach-solvent extraction mill started operation, and has run continuously since that date. The original plant was described in the Aug.-Sept.-Oct., 1962 issue of the Deco *Trefoil* (Bulletin No. M4-B115), and is the subject of this account of the recent doubling of capacity. Although the process has not essentially been changed, there have been significant developments in equipment, and the expansion of the plant was accomplished in a most ingenious manner.

This article relates to the changes that have taken place, and the method and equipment by which the plant expansion was accomplished.

Administration and Operations

The structure of the Petrotomics Company remains virtually the same as reported in Bulletin No. M4-B115, with the exception that now the Getty Oil Company is the managing partner.

Direction of operations that include this venture rests with Getty Oil personnel under Mr. J. P. McCabe, general manager of Special Projects Division; Dr. Siegfried Muessig, manager of minerals exploration and mining; and Mr. Norman A. Grant, manager of mining operations. Their offices are in Los Angeles, Calif.

Manager of the Petrotomics Company at Casper, Wyoming, is Mr. Judson H. Whitman. His staff includes the following personnel:

Mr. C. D. Pollicino, chief accountant.
Mr. W. K. Hornsby, purchasing agent.
Mr. C. R. Wurster, personnel and safety coordinator.
Mr. Robert Jones, planning engineer.
Mr. O. David Niedermeyer, Jr., mine superintendent.
Mr. C. E. Wolff, mill superintendent.
Mr. J. W. Rosson, maintenance superintendent.

A/3

Left to right, G. A. Hamar, Mill Foreman; H. G. Cooley, Metallurgist; O. P. Moon, Mill Maintenance Lead Man; C. M. Bittle, Mill Shift Foreman; P. J. Thornburg, Chemist; C. E. Wolff, Mill Superintendent.

The milling operations include the following personnel:

Mr. G. A. Hamar, mill foreman.
Mr. H. G. Cooley, metallurgist.
Mr. P. J. Thornburg, chemist.
Mr. R. W. Beattie, mill maintenance foreman.
Mr. O. P. Moon, mill maintenance lead man.
Mr. A. P. Jackson, shift foreman.
Mr. G. E. Latimer, shift foreman.
Mr. J. Michael, shift foreman.
Mr. C. M. Bittle, shift foreman.

Operating crew for the mill totals 58 men, in the following categories:

Mill superintendent	1
Mill foreman	1
Metallurgist	1
Chief chemist	1
Maintenance foreman	1
Maintenance lead man	1
Shift foreman	4
Analytical lab technicians	2
Crushing plant (Includes 4 operators, 2 loader operators and 1 dozer operator)	7
Mill operators	18
Helpers	4
Mill laborer	7
Mechanics	7
Mechanic helpers	3

Mining

The milling plant, started in 1962, received ore from an open pit on which stripping had started in July of 1959. Since that time, the original pit was worked out, and several nearby smaller pits were worked until recently, when a new pit, known as the Dave Pit was placed into production.

Left to right, Gordon T. Swanby, Project Manager for Stearns-Roger Corp., who handled the mill expansion; Judson H. Whitman, Manager of the Petrotomics Company Shirley Basin Operation; C. E. Wolff, Mill Superintendent; W. K. Hornsby, Purchasing Agent.

Stripping of the new pit started in 1966, and in general entails the removal of a depth of about 150 feet of overburden to expose a depth of about a 50 to 70 foot horizon containing rolls or lenses of milling ore.

In early operations mining was done using a 2-yard Bucyrus-Erie shovel, and a Koehring back-hoe. The ore was hauled in 14.7 cubic yard capacity Euclid trucks, to the mill one-half mile away.

Contrast to present operations is indeed great. Early in 1968 the company brought in new equipment for removal of overburden, consisting of a 17 cubic yard Bucyrus-Erie shovel, electrically powered from Hot Springs R.E.A. generating plant, and a fleet of seven Lectra-Haul 100 ton capacity trucks. These trucks have an electric motor driving each rear wheel, powered by a generator driven by the truck motor.

The *Riverton Ranger* reports that the daily capacity of this shovel and truck fleet is about 37,500 tons, or equivalent to a train of 750 ore cars, 50 tons each, which would stretch out over six miles of track.

The Dave Pit is two miles from the mill, and ore is hauled to the mill feed stock pile in 35-ton Euclid and Dart trucks, at a rate of about 1,400 tons per day.

Each truck load is weighed on a platform scale and ore grade is estimated by an Eberline counter. Ore is stock piled in accordance with estimated grades, then blended for mill ore feed of a reasonably uniform grade.

The lower grade ore from fringe areas of the pit, in excess of that which may be blended with higher grade ore, is heap-leached. This is described later.

Design and Construction

The original mill was designed and constructed during the period of June, 1961 to April 5, 1962 by the Stearns-Roger Corporation, utilizing the flowsheet and metallurgical criteria resulting from test work performed by Kerr McGee Oil Industries, Inc., and in cooperation with A. H. Ross and Associates of Toronto, Canada as metallurgical consultants.

Early in September of 1967 the plant expansion was authorized, and Stearns-Roger Corporation was again engaged for the design and construction. This work was under the direction of Mr. Gordon T. Swanby, project manager. Mr. Russ Hankel was the project engineer, and Mr. Wayne Varah was the field superintendent in charge of the construction.

The construction was completed with virtually no loss of production except for very short periods when changes over to the expanded circuits were made. Doubling of the capacity was accomplished at a very favorable cost. The fine manner in which the job was done, practically and economically, was due to the effort of the many people involved — full cooperation of the Petrotomics maintenance and operating crews and the Stearns-Roger field construction crews.

About the middle of June, 1968, the expansion was on stream and at full rated capacity within a few weeks. Following is a description of the revised flowsheet, changes and additions that were made, and details of present operations.

Crushing

There were no changes made in the crushing plant, to the present time, although a new and larger impact crusher has since been installed replacing the present unit to ease the crushing burden. Secondary crushing becomes difficult when the ore is wet, or frozen, as during the winter months, and it is anticipated that the new crusher, of the swing-hammer type, will relieve difficulties encountered under these conditions.

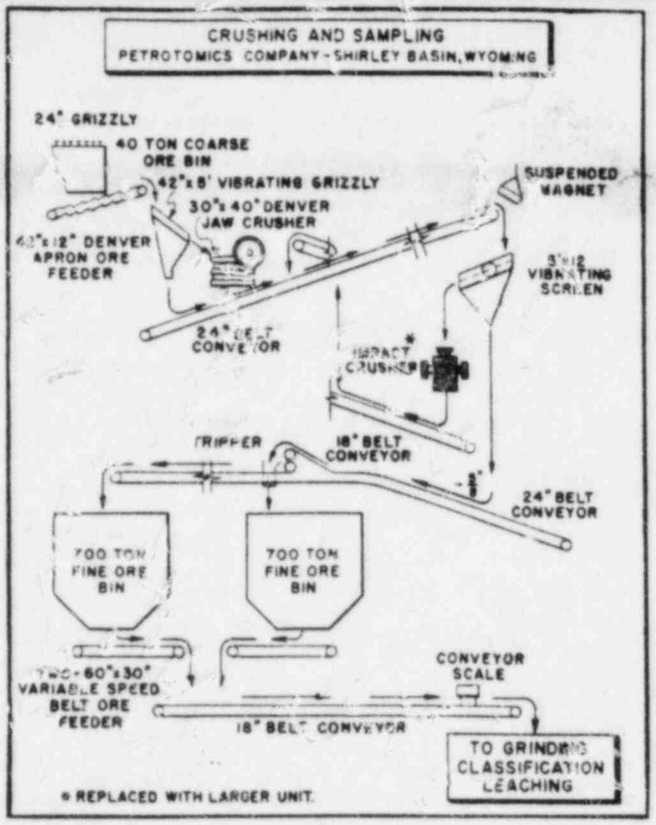
Ore to the primary crusher is limited in size by a grizzly with 24″ spacing. The primary crusher reduces it to 4″, and the hammer mill to the final minus 1″ mill feed size. The hammer mill operates in closed circuit with a 5′ x 12′ vibrating screen.

Grinding

The 6′x8′ overflow type ball mill originally installed was quite adequate for the 500 tons per day plant and had at times ground over 600 tons per day. There was adjacent space sufficient to install a new duplicate mill, and this was done.

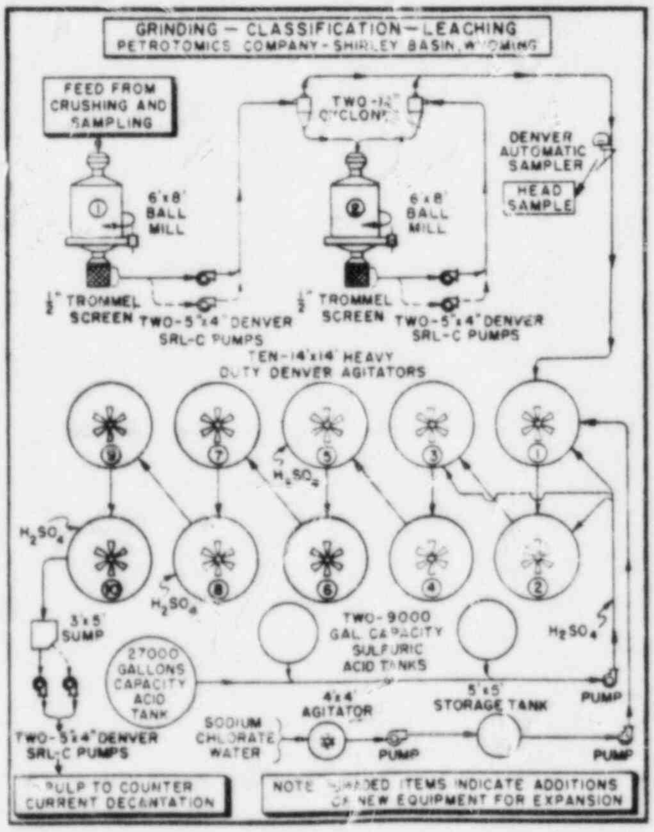
The existing belt conveyor from the ore feeders under the mill ore bins was not changed, but at first a splitter was inserted at the conveyor discharge to divide feed between the old and the new mill. However, it was difficult to maintain an even split between the two mills, and cyclone control and grinding performance required a lot of attention. It was decided therefore to change the circuit.

Present flow of ore is not split, but goes to one mill, the older one, and the discharge from this mill is pumped to the first cyclone. This cyclone overflow is maintained as a finished grind, going to the leach agitators. The underflow from this cyclone is fed to the second mill, the new one, and the discharge from this mill is pumped to the new cyclone. The overflow from this cyclone joins that of the first going to the leaching agitators. The underflow is returned to the second mill, closing the circuit.



Ball charge, at 45 percent volume is made up of molybdenum-copper-alloy forged steel grinding balls. Consumption has been 0.75 pounds per ton of ore feed. mill liners are presently double wave type manganese steel with an expected life of 225,000 tons of ore for each mill.

Discharge from the new ball mill is pumped to the cyclone by a 5″ x 4″ Denver SRL-C Pump, with a duplicate pump as standby, the same as the pumps used for the original circuit.



Cyclone overflow, at 52 percent solids flows by gravity to a sampler, and thence to the first leach agitator.

It is too early to state operating data on this two-stage grinding circuit, but from current operations it is apparent that the final results will be essentially the same as with the divided circuit, but with considerable easing of operating controls.

The feed to the primary mill is 45 tons per hour of minus 1" ore and grinding is done at 66% solids. Each of the 6' x 8' overflow type ball mills is powered by a 150-hp motor. Cyclone overflow is held to minus 28-mesh.

Leaching

The number of 14' x 14' Heavy Duty Turbine DENVER Agitators was doubled, from 5 to 10, all ten operating in series, retaining the same retention time of nine hours on the cyclone underflow pulp at 52 percent solids.

The new installation did not require moving or re-arranging the existing agitators, and the provision to by-pass feed from any unit to the next was retained so that the circuit would not be disturbed for inspection or maintenance of any of the units.

Reagents to the leach agitators are sulphuric acid and sodium chlorate, as referred to in the section on reagents.

Each agitator has a 4" stave and bottom wood tank, with DENVER Mechanism and superstructure utilizing a No. 10 DENVER Reducer Drive, rubber covered 54" diameter 6-blade, rubber covered axial flow DENVER 150% Pitch Propeller, rubber covered shaft and driven with 20-hp motor.

Discharge from the final agitator flows to a pump sump and a 5" x 4" DENVER SRL-C Pump sends the pulp on to the counter-current decantation system.

Counter-Current Decantation

In this section more extensive change was required, not in location of existing equipment, but in flow lines between the old and the new. The six original 55' diameter x 12' deep Heavy Duty Acid-Resistant DENVER Thickeners in series were retained as installed, and three new 80' diameter x 12' deep Acid-Resistant DENVER Thickeners were erected in an adjacent open area.

Three new 80 ft. diameter by 12 feet deep DENVER Acid-Resistant Thickeners were added for increased plant capacity. DENVER Diaphragm Pumps and DENVER SRL Pumps are housed in the small building at the center of the "clover leaf" arrangement of the thickeners.

These three 80' thickeners are in series, the first receiving pulp flow from the leach agitators at the rate of more than 1,000 dry tons of ore per day, and the solids going successively to the second and to the third thickener.

The underflow, containing 59 percent solids, is pumped and metered from each of these thickeners by a 6" Model EC Duplex DENVER Adjustable Stroke Diaphragm Pump, to the following thickener, excepting the last, or number 3, pump discharge.

Overflow from the third thickener is pumped back to the second thickener, and overflow from the second thickener is pumped back to the first thickener in each case by a 5"x 4" Acid-Resistant DENVER SRL-C Pump.

In order to preserve six stages of counter-current washing, as in the original plant, the underflow from the No. 3 80-foot thickener, after metering and pumping from the last 6 inch DENVER Diaphragm Pump drops to a pump sump and is then pumped with a 5" x 4" DENVER SRL-C Pump to a splitter.

Here the flow is equally divided into two streams, one-half going to the first of the original six thickeners, and one-half going to the fourth thickener. The first three of this line are in series, and the last three are in series. The underflow from the third thickener (No. 6A on the flowsheet) and the sixth (No. 6B on the flowsheet) thickener are final tails and are pumped to the tailings pond.

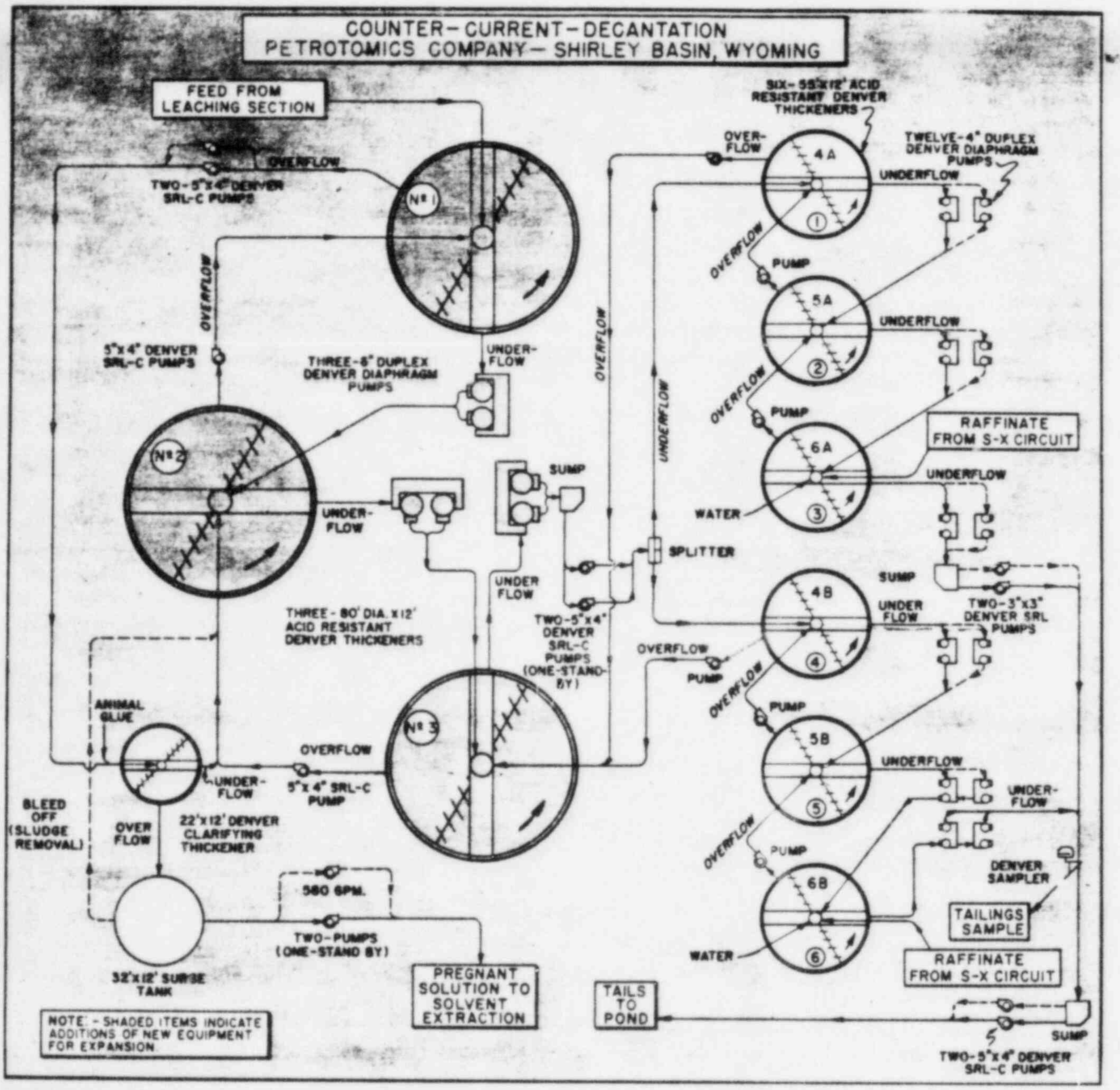
The layout and arrangement of the three new thickeners and diaphragm pumps is worthy of special attention. The thickeners are placed like the leaves of a clover, with the center being a pump house that accommodates all three of the diaphragm pumps on the upper levels and the centrifugal pumps on the lower level. Each of the diaphragm pumps is located at the liquid level of its corresponding thickener, so that the head requirements are low.

Grouping the pumps in one small house permits economical building requirements, protection from the weather, and convenience for operations and maintenance. Within the house also is the control panel for these thickeners and their related pumps, with appropriate signal lights so that an operator can see at a glance whether or not all equipment is functioning.

The arrangement also provides for the rapid and easy by-passing of any one of the three pumps or thickeners for maintenance or inspection purposes.

Each of the 80 foot thickeners is operated by a 5-hp motor and has a manually operated lifting device to provide for 18" lift of the rakes. Each of the 6" duplex diaphragm pumps is operated by a 5-hp motor.

Solution for wash and make-up for the thickener or decantation circuit is the raffinate that is returned from the solvent extraction circuit.



The overflow from the first thickener, or pregnant liquor, carries from 0.75 to 1.1 grams U_3O_8 per liter and flows by gravity to a 22′ x 12′ DENVER Clarifying Thickener. Underflow from this thickener is pumped by a 5″ x 4″ DENVER SRL-C Pump to thickener No. 2, and the overflow is pumped to the solvent extraction circuit.

Solvent Extraction

In order to obtain clear solution from the overflow from the final clarifying thickener in the decantation circuit, the remaining fine solids are removed by means of pre-coat filters. The original unit, about 300 square feet of filter area, has been retained to serve as a standby unit, but the plant flow now normally goes to a new pre-coat filter with about 600 square feet of filter area. This solution, or generally termed pregnant liquor, is pumped to the first stage of solvent extraction.

Here again the original extraction and stripping stages were not disturbed, but duplicate units were added in open area beyond the existing units. The feed of pregnant solution was divided, one-half to the old and one-half to the new extraction units.

Each of the circuits, No. 1 and No. 2 are the same. Each has four extraction stages and four stripping stages. As in the original plant, concrete tanks, compartmented for extracting and stripping stages, and lined with fiber-

glass, were used, and DENVER Solvent Extraction Pumping Turbines were used, duplicating original equipment.

The pregnant liquor entering the first stage of extraction carries from 0.75 to 1.1 grams U_3O_8 per liter. As it progresses through the four stages, the U_3O_8 is gathered by the reagents carried in the organic, and when it leaves the final stage it is reduced to a minimal amount of uranium. Recovery from the pregnant liquor by solvent extraction exceeds 99 percent of the contained uranium.

The liquor from which the uranium has been extracted, the "raffinate" is pumped twenty-five percent to the tailings pond, and seventy-five percent to a raffinate storage tank. Raffinate is pumped to the last of the counter-current decantation thickeners, No. 6A and No. 6B, where, with some water, it provides a solution balance for the system.

While the liquor progresses through the extraction stages it is in each case thoroughly mixed with the reagent-carrying organic, allowed to settle to separate organic and liquor, and the organic flowing counter-current to the liquor. In other words, the barren organic enters the No. 4 extraction stage, and leaves the No. 1 extraction stage, carrying the load of uranium it has gained. The barren organic carries less than 0.05 grams per liter of U_3O_8 and leaves as pregnant organic carrying 2.5 grams per liter.

Next, the uranium is "stripped" from the reagents carried by the organic. This is done in four stripping stages. Organic flows from the first through the fourth stage, while strip solution flows counter-currently from the fourth stage through the first stage.

The strip solution comes from recycle after precipitation of U_3O_8, plus water as required, with regulation such that when leaving the stripping stages it carries 0.35 grams per liter U_3O_8.

Stripping is accomplished by close acidity control using an ammonium sulphate solution, so that uranium oxide and sulphuric acid are removed from the organic by ion exchange with the ammonium sulphate.

Solvent extraction units are housed in a separate building. Tanks are covered, and the DENVER Turbine-Type Solvent Extracton Mixers provide the thorough mixing required for each stage.

This has been a change from previous operations at this plant. Formerly the strip solution was made up with sodium chloride, and precipitation by means of magnesium oxide. This however resulted in some sodium content in the final plant product, which was undesirable. With the ammonium salts and ammonia precipitation, this element in the product is minimized.

The barren organic from the stripping stages returns for re-use in the extraction stages.

Precipitation and Filtration

The loaded strip solution is pumped to two 6′ x 6′ mixers, in series. Anhydrous ammonia is used in the mixers to accomplish precipitation of U_3O_8, and is also added to each of three DENVER 10′ x 12′ Paddle Agitators which are in parallel, each receiving discharge from the second mixer. A stand-by line is maintained which permits cutting out the two mixers, and one of the three paddle agitators can be cut out as desired.

The control of acidity for precipitation must be precise. In the first of the two mixers the pH is brought to 6.1 by the ammonia addition, and in the second it is brought to a pH of 6.8 to 7.0. These stage additions are made to control as largely as possible the sulphate content of the precipitate.

The precipitate and liquid from the paddle agitators is pumped to a Whitco plate and frame filter press, and filtrate from this press is pumped to a second, or "polishing" Shriver plate and frame filter press.

The filtrate from this press, along with water as needed, is used to make up the ammonium sulphate solution used for the solvent extraction stages, and a part is bled off to mill tailings to avoid excessive build-up of impurities in the circuits.

Drying and Packaging

The precipitate from both of these filter presses is repulped with water in a 6′ x 6′ DENVER Turbine-Type Agitator and to about 65 to 70 percent solids, and then pumped to the top hearth of a 6′ diameter x 6 hearth multiple hearth dryer. Fuel used for firing is propane gas. Drying is carried on at about 750°F.

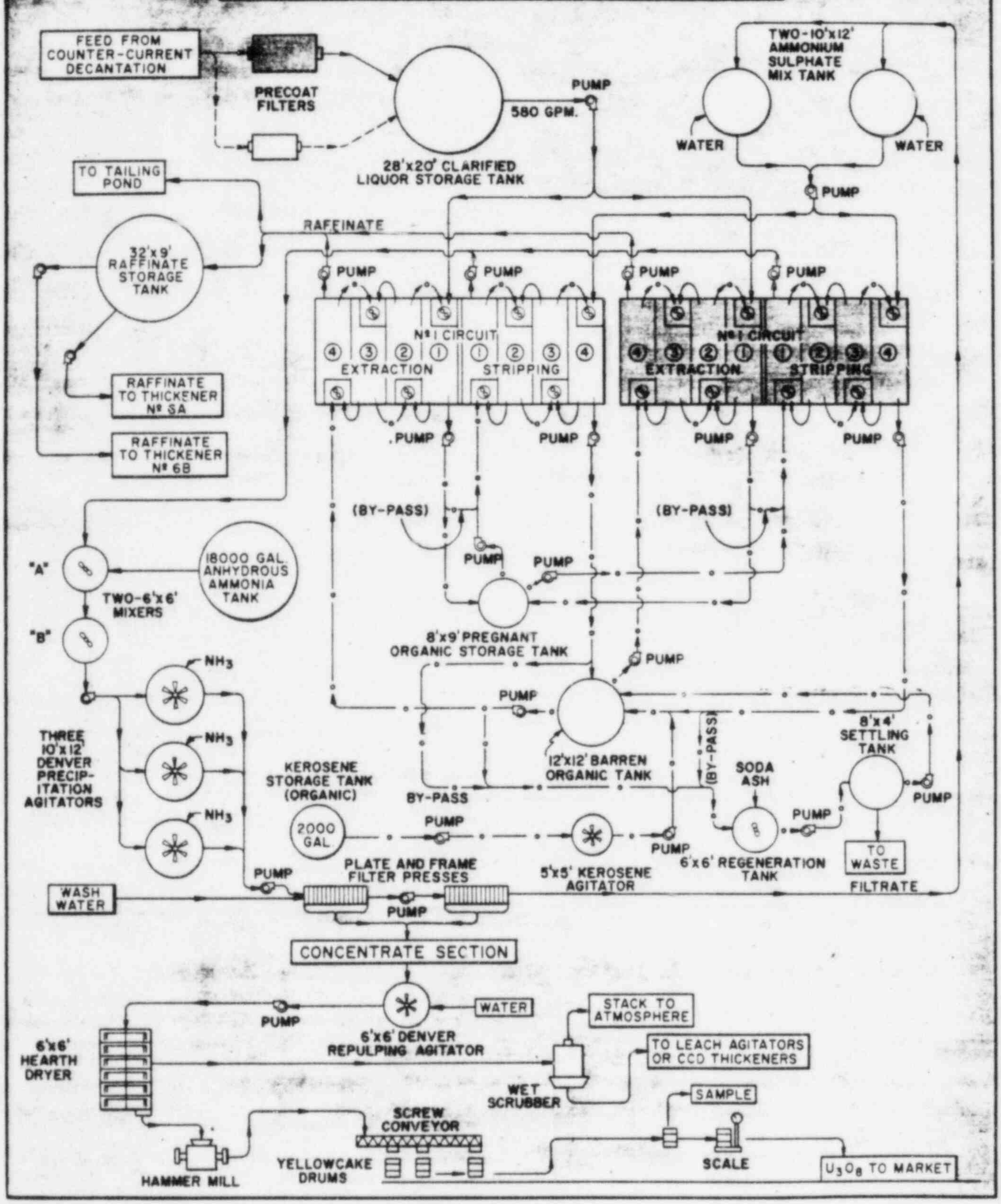
Gas and dust taken off over the top hearth goes to a Rotoclone wet scrubber, and dust is collected into a sludge while gas passes to atmosphere. The scrubber sludge is pumped to either the leach tanks or to the counter-current decantation thickeners.

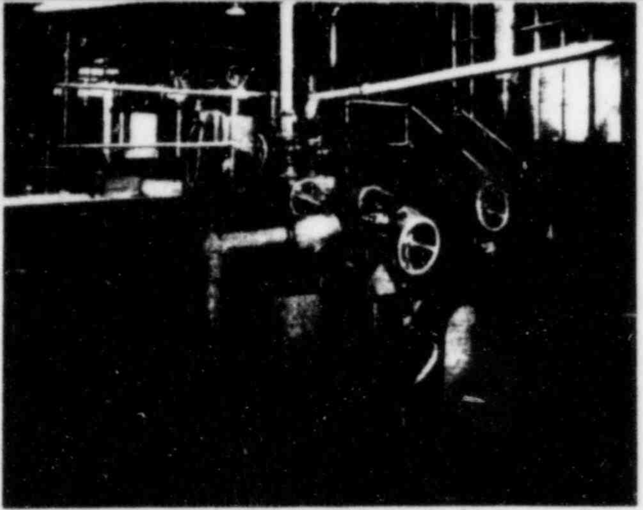
Formerly a dry dust cyclone was used between the furnace and the wet scrubber, but has been eliminated as needless.

The dried precipitate, or concentrate, from the furnace, containing less than 0.5 percent moisture, is broken to minus ¼″ size and carried by a screw conveyor to fill 55 gallon drums for shipment to market. Each drum weighs about 950 pounds.

The final concentrate runs from 92% to 98% U_3O_8.

SOLVENT EXTRACTION CIRCUIT
PETROTOMICS COMPANY—SHIRLEY BASIN, WYOMING





Six inch Duplex DENVER Adjustable-Stroke Diaphragm Pumps are set on three levels, corresponding to thickener levels, within the central pump house.

Reagents

Sulphuric acid, about 93 percent strength, is added at the first leach tank following grinding. Consumption is 95 to 105 pounds per ton of ore.

Sodium chlorate is dissolved in water in a 4′ x 4′ agitator, and added at a solution strength of about 25 percent, to the first leach agitator. Consumption is 1.5 to 2.0 pounds per ton.

Flocculants are used in the counter-current decantation thickeners and are Tylac M-11 at 0.05 pounds per ton of ore, and animal glue at 0.07 pounds per ton of ore. The glue is useful to flocculate the bentonitic material.

After clarification of the pregnant liquor, 0.05 pounds per ton of Solkafloc and 0.75 pounds per ton of Dicalite are used as filter aids for the precoat filters.

Consumption of reagents for the solvent extraction circuit are kerosene at 0.02 gallons per ton of ore, Tridecanol at 0.04 pounds per ton and Adogen 364 (amine) at 0.05 pounds per ton. Since the change from sodium chloride to ammonium sulphate in the stripping circuit, and anhydrous ammonia for precipitation instead of magnesium oxide, the exact consumption has not been determined, but it is expected that ammonium sulphate will be in the range of 0.4 to 0.6 pounds per ton, and anhydrous ammonia at about 0.15 pounds per ton.

Sampling

Only two automatic sampling systems are used for mill control. Feed material is sampled after grinding, at a point where the overflow from the cyclones enters the first leaching agitator. Here sampling is done by a DENVER Automatic Sampler and the sample cut is further reduced in volume by two 16″ DENVER Vezin-Type Wet Automatic Samplers in series. Rejects from all these samplers flow by gravity into the agitator.

The other automatic sampler is on the mill tailing as it enters the pump sump for pumping to the tailings pond. This is a DENVER Automatic Sampler, without use of any secondary sampler, and a cut is taken each 20 minutes.

All other samples, principally all solution flows, are taken by hand once each hour.

Heap Leaching

Ore that is too low in grade for mill feed, and excess over what can be economically blended with higher grade for mill feed is heap leached in an area adjacent to the mill.

The leach pad is about 150′ x 150′ in area, and is loaded to a depth of about 15′. The bottom is protected from seepage, and liquor collected, on 6 to 8 mil thick Polyvinyl chloride sheeting, on top of which at about 36′ centers are perforated Orangeburg plastic pipes for drainage of liquor from the pad. Between each of these pipes the bottom raises, so that drainage travels 18′ to each pipe.

Raffinate from the plant at about 25-gpm is used for this leach, and floods paddies which are arranged in squares of about 40′ by 40′ on the top of the heap.

Drainage from the perforated plastic pipes is directed to one of two sumps which are excavations each about 40′ x 40′ area. Seepage is prevented by use of PVC sheeting of about 20 mil thickness.

When the liquor in a sump reaches a strength of 0.5 grams per liter of U_3O_8 it is pumped to the solvent extraction circuit in the mill. If it has not reached the desired strength, it is pumped to the leach heap, and thus recirculated until proper strength is reached.

Heap leaching recovers about 75 percent of the U_3O_8 contained in this low grade material.

Conclusion

The expansion of the Petrotomics Company plant has been accomplished to the pride and satisfaction of all concerned. Careful planning, engineering, construction, and plant operations all combined for the notable result of minimum lost production, moderate capital cost, and an enlarged plant that got on-stream with very few and rather minor operational problems.

Changes in process and flowsheet over the years have resulted in improved performance. An enthusiastic, alert and competent staff looks to the future, for even better operations, if possible, and continuing growth.

Acknowledgment

The editors of DECO *Trefoil* and the Denver Equipment Company, Division of the Joy Manufacturing Company, gratefully acknowledge the cooperation, the time, information and technical data given by the staff of Petrotomics Company, and in particular Mr. Gordon T. Swanby, project manager for Stearns-Roger Corporation, Mr. Judson Whitman and Mr. Charles Wolff of the Petrotomics Company.

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FOR YOUR ENGINEERING NOTEBOOK

FILE NO. BULLETIN NO M4-B115
SUBJECT MILLS, URANIUM
SOLVENT EXTRACTION
500 TONS PER DAY

THE PETROTOMICS URANIUM MILL

Shirley Basin, Wyoming

By FRANK A. [illegible]TON, Manager Metallurgical Operations Division, Denver Equipment Company

Aerial view of the 500 ton per day Petrotomics Uranium Mill with office, cafeteria, and sleeping quarters in foreground. Open pit mine is partially visible in upper right hand corner. The 5,000,000 gallon water storage pond is in the upper center. The tailing area (not visible) is 1600-feet from the last thickener. The mill design and construction were by Stearns-Roger Manufacturing Company, who supplied the photos for this article.

Introduction

The relatively recent discovery of significant uranium deposits in the Shirley Basin area of Wyoming enhanced Wyoming's position as a major uranium producer. Extensive exploratory work starting early in 1957 confirmed the existence of substantial reserves in the Shirley Basin area and initiated the formation of the Petrotomics Company, a partnership consisting of Tidewater Oil Company, Kerr - McGee Oil Industries, Inc., Skelly Oil Company, and Getty Oil Company. The Tidewater Oil Company is the operating partner. Following the approval of an AEC milling contract, Petrotomics Company constructed a 500 ton per day acid leach-solvent extraction mill to process their Shirley Basin ores. Milling commenced April 5, 1962.

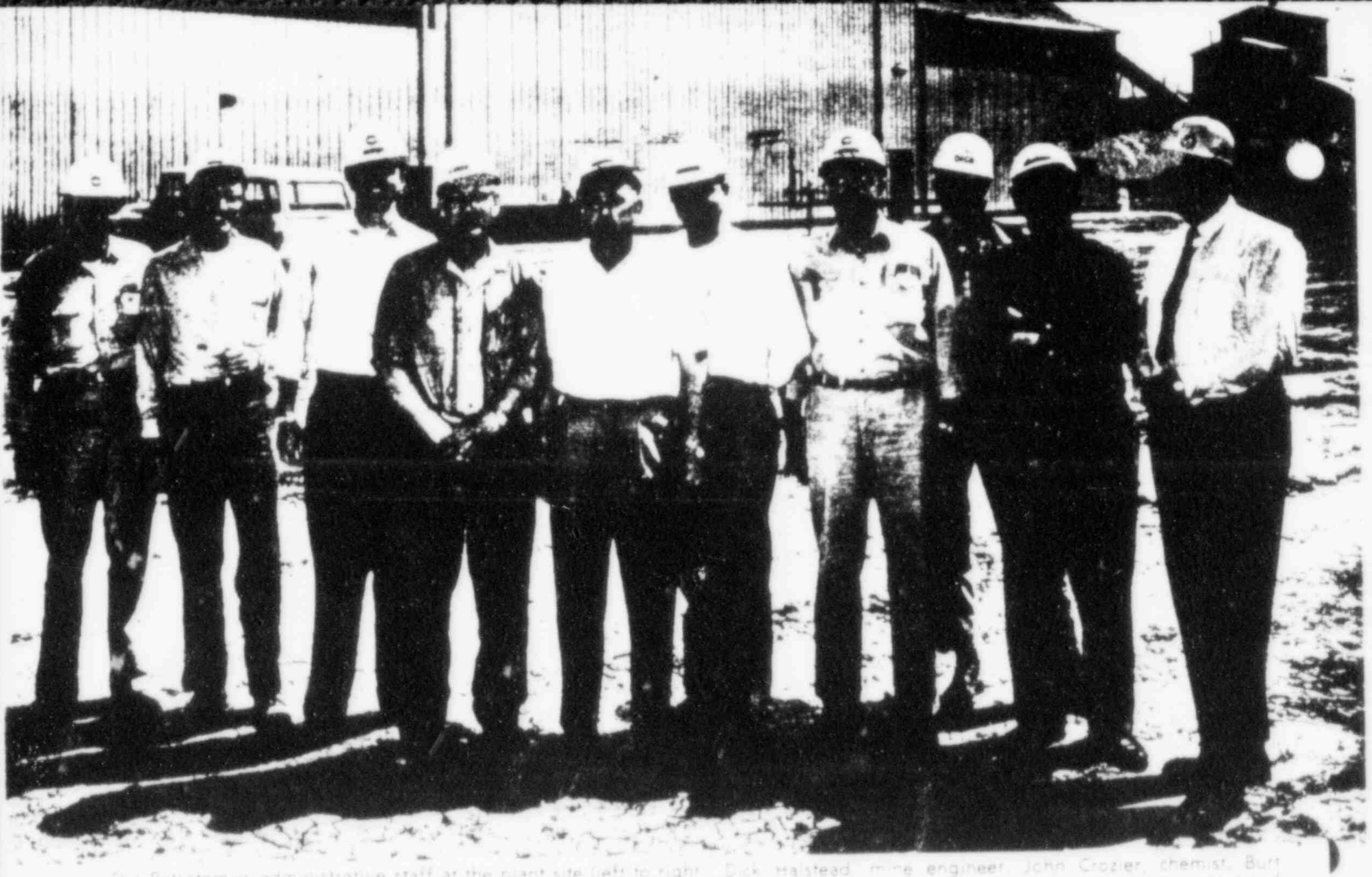
Location

The topography of the mill site area is relatively flat and is at an elevation of 7,000 feet. Casper, Wyoming, is the nearest town of significant size and is approximately 40 airline miles north of the mill. The property is accessible by road from either Casper or Medicine Bow, Wyoming, on State Highway 487 and then 15 miles of dirt road off the highway.

Administrative Staff

The administrative staff at the plant site consists of the following:

Norman A. Grant	Project Manager
G. K. Coates	Mill Superintendent
Emmerson Kemp	Metallurgist-General Foreman



The Petrotomics administrative staff at the plant site (left to right): Dick Halstead, mine engineer; John Crozier, chemist; Burt Moulden, employee relations and radiology; G. Ken Coates, mill superintendent; Wayne K. Butcher, administrative assistant and office manager; Emmerson Kemp, metallurgical foreman; George T. Beardshear, mine superintendent; Dick Daniel, mine geologist; R. D. Cypert, Jr., project geologist; Norman A. Grant, project manager.

John Crozier	Chemist
Burt Moulden	Employee Relations & Radiology

Other administrative personnel are:

George T. Beardshear	Mine Superintendent
Dick Halstead	Mine Engineer
R. D. Cypert, Jr.	Project Geologist
Dick Daniel	Mine Geologist
Wayne K. Butcher	Administrative Assistant and Office Manager

Motel-type sleeping quarters are available for personnel between shifts, but no permanent facilities are available. Most of the employees live in Casper or other nearby towns. A modern cafeteria is operated for the convenience of employees.

Table I shows a list of the mill personnel.

Geology

The ore occurs as uraninite adhering to the outside of sand grains in the Wind River formation which rest unconformably upon Cretaceous shales. The ores are relatively low in clay content and generally regarded as exceptionally clean ores from the standpoint of objectionable impurities. The arkosic sands in which the ore occurs are very porous and permeable, having been laid down in scoured channels in the bentonitic clays.

Mining

Although extensive ore reserves in the area will require underground mining methods, significant ore reserves were also found near the surface which can be mined by open pit methods. All ore presently being mined by Petrotomics Company is by open pit under contract to Plateau Construction Company of Rawlins, Wyoming. Initial stripping of 2.3 million yards of overburden started in July, 1959 using Euclid TS24 scrapers and Euclid tractors for pushers. The ore zone is mined using a 2-yard Bucyrus-Erie shovel and a Koehring shovel equipped with a backhoe front and also a crane front for drop ball use. Euclid trucks of 14.7 yard capacity with heated boxes are used for haulage to the mill which is one-half mile away. Ore control is stressed and accurately followed.

Future mining will utilize backfilling of the mined out pits for holding stripping waste instead of dumps. Stripping is carried out with four scrapers on two shifts. Mining is performed on day shift only. Mercury vapor flood lights are placed at essential points where night stripping is taking place. The water encountered in mining has ranged between 200 and 350-GPM and is pumped from the low point in the pit utilizing a 40 HP pump mounted on a floating platform.

The mine-run ore, after being scalped of minus 4-inch fines, is crushed in a 30" x 40" DENVER Jaw Crusher. Oversize crusher was selected to accommodate large size lumps and thus avoid secondary breaking in the pit.

With the exception of occasional lenses of hard limestone, no blasting is required. The mill feed consists entirely of the ore mined by Petrotomics. The feed assays 0.25 to 0.30 U_3O_8, and the overall recovery is in the mid-nineties.

Test Work

The test work was performed in the metallurgical laboratories of Kerr McGee Oil Industries, Inc., near Golden, Colorado, by Mr. Emmerson Kemp, Metallurgist for Petrotomics Company and the Kerr-McGee research staff, in cooperation with A. H. Ross and Associates, of Toronto, Metallurgical Consultants to Petrotomics. The latter are also metallurgical consultants for the operation.

Design and Construction

As soon as the flowsheet was finalized in June, 1961, Stearns - Roger Manufacturing Company was engaged for the mill design and construction. Mill design and construction started immediately. Despite the severe winter, which had temperatures of 30° below zero and colder, construction was completed on schedule and milling commenced on April 5, 1962. Mr. Harry J. McMichael and Mr. Bruce H. Irwin were project manager and project engineer, respectively for Stearns-Roger, and worked in close cooperation with Mr. Norman Grant and Mr. Emmerson Kemp of the Petrotomics Company and A. H. Ross and Associates during all phases of design and construction. This modern mill and flowsheet is a tribute to present day engineering practices. Simplicity was the keynote of the efficient Petrotomics Mill design.

Water

All water used in milling originates from the open pit mine. The mine water is pumped to a 5,000,000 gallon holding pond and then to an elevated 200,000 gallon water tank. The top one-half of the tank capacity is available for milling purposes. If the water level should drop to this point, there is still water available for fire protection. The water pressure in the plant is 50-psi.

Power

Power is supplied by the R.E.A. at 39,000-volts and reduced to 13,000-volts at the mill substation. All mill equipment operates at 440 and 110-volts. The mill has approximately 750 connected horsepower. A stand-by 250 KVA power unit is available in the mill to supply emergency power for the leach agitators, thickeners, tailing pumps, boilers, lighting, and other uses in the office, cafeteria, and sleeping quarters.

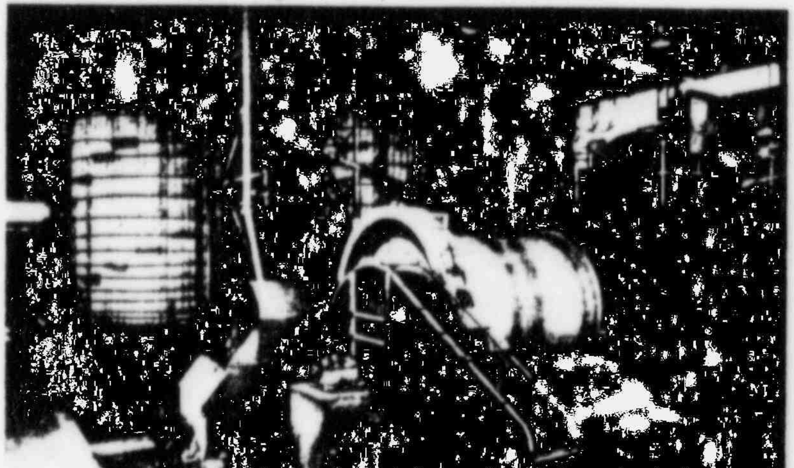
Milling

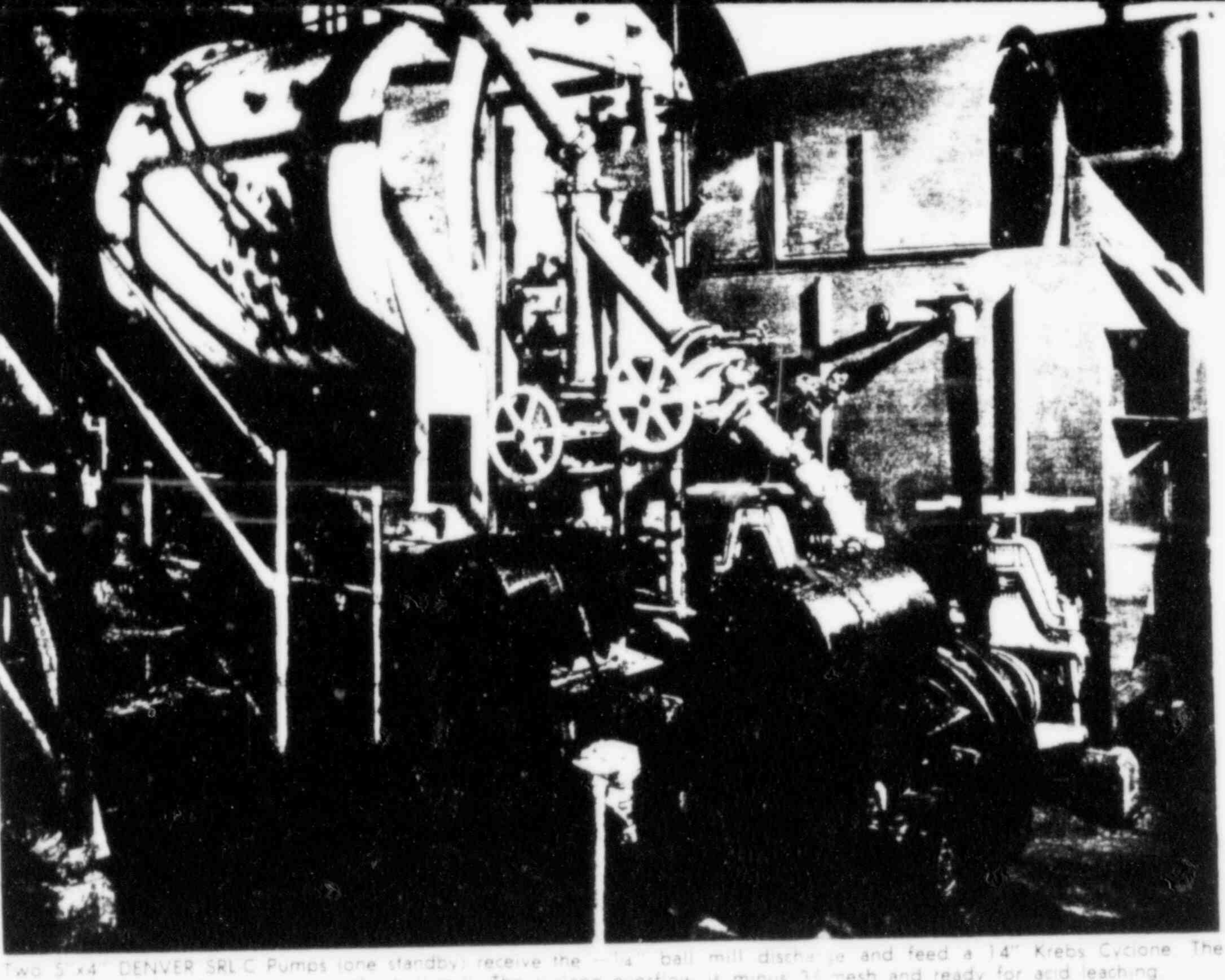
The milling process consists of crushing, grinding, acid leaching, countercurrent decantation, solvent extraction of the pregnant liquor, and precipitation as shown on the flowsheet. Additional details are given below.

Crushing

The ore from the mine is dumped directly into the 40 ton coarse ore bin using 22 ton trucks or by means of a four yard front end loader from the ore stockpiles. The coarse ore bin, which is equipped with a 24" opening rail grizzly, is discharged by a 42" x 12' Denver Apron Ore Feeder to a 42" x 5' vibrating grizzly with a 4" opening. The ore is very soft and sandy in nature so a large part of the feed is immediately removed as

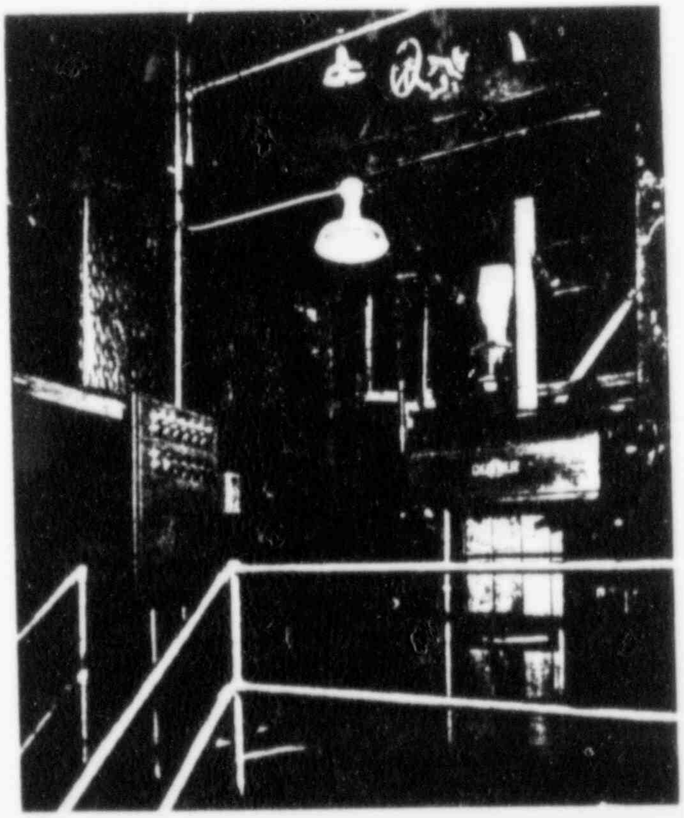
Inside the mill looking toward grinding section with the leach agitators in the background. Mill floor is on one level with operating walkways above.





Two 5"x4" DENVER SRL-C Pumps (one standby) receive the —¼" ball mill discharge and feed a 14" Krebs Cyclone. The cyclone underflow returns to the ball mill. The cyclone overflow is minus 35 mesh and ready for acid leaching.

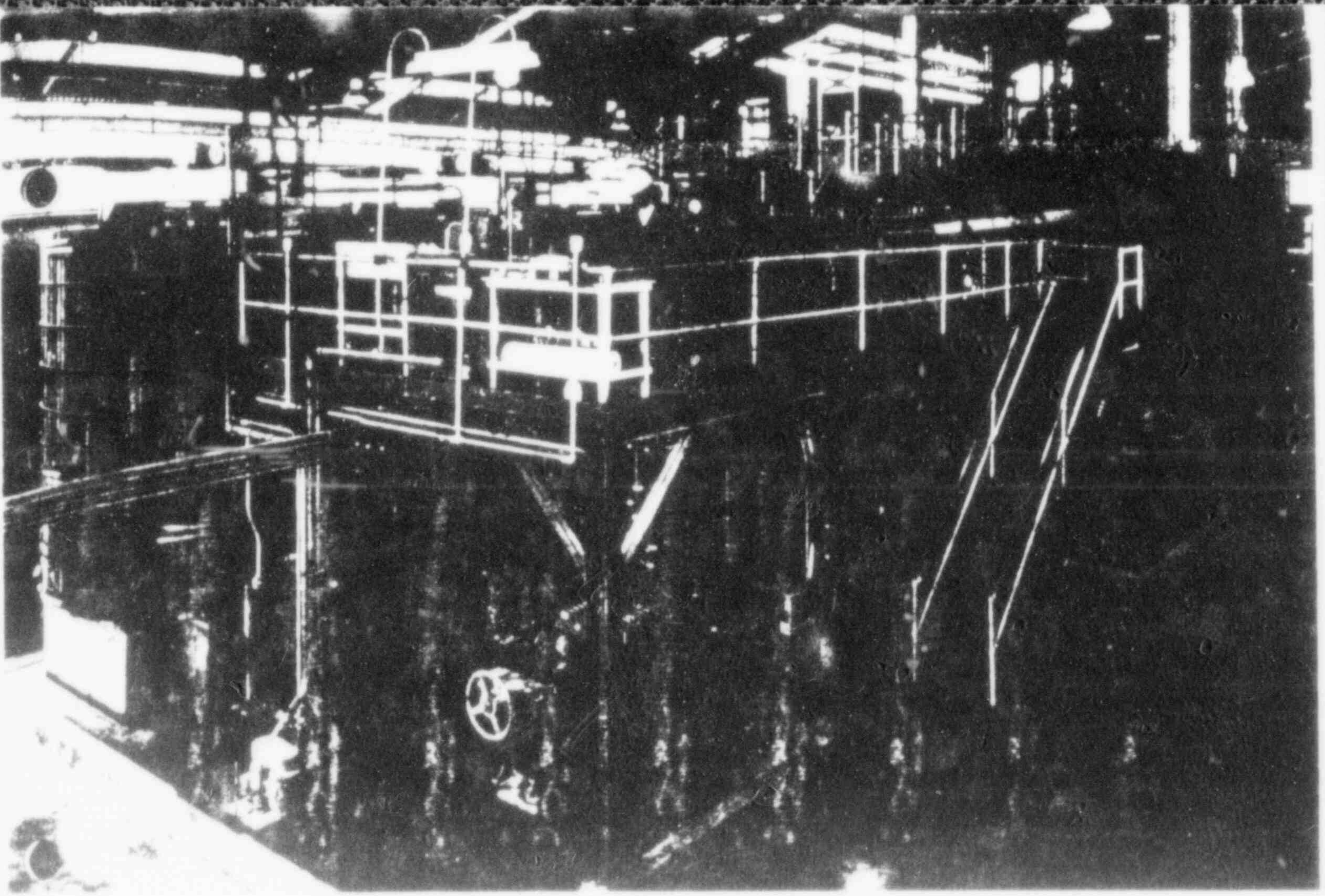
The cyclone overflow at 52% solids is sampled with a DENVER Automatic Sampler to constitute the plant head sample. Cyclone overflow, after sampling, flows by gravity to the raw leach section.



primary undersize by the vibrating grizzly. The oversize (plus 4-inch) from the grizzly passes to a 30" x 40" Denver Jaw Crusher. This crusher is of much larger capacity than actually required but was selected to accommodate large size lumps and to avoid secondary breaking in the pit. A hopper with screw conveyor discharge is placed under the apron feeder to continually remove any leakage of fine sand and convey it to the primary belt conveyor.

A 24" belt conveyor with a suspended magnet over the head pulley delivers the grizzly undersize and jaw crusher product to a 5′ x 12′ vibrating screen equipped with a ⅝" x 5" slotted-type screen deck. The screen oversize passes to an impact crusher and is then returned to the primary conveyor by means of an 18" conveyor. This provides closed circuit secondary crushing operation. The vibrating screen undersize discharges to a 24" belt conveyor with a tripper to deliver the fine ore to one of two 700-ton fine ore bins. The design capacity of the crushing plant is 125 tons per hour. The fine ore bins are of conical-shape with large area bottom openings to facilitate discharging damp ore.

No dust collection facilities are required in the crushing plant but all chutes are hooded. The mill feed sample is taken after grinding and classification.



[illegible]

Grinding

[illegible]

Leaching

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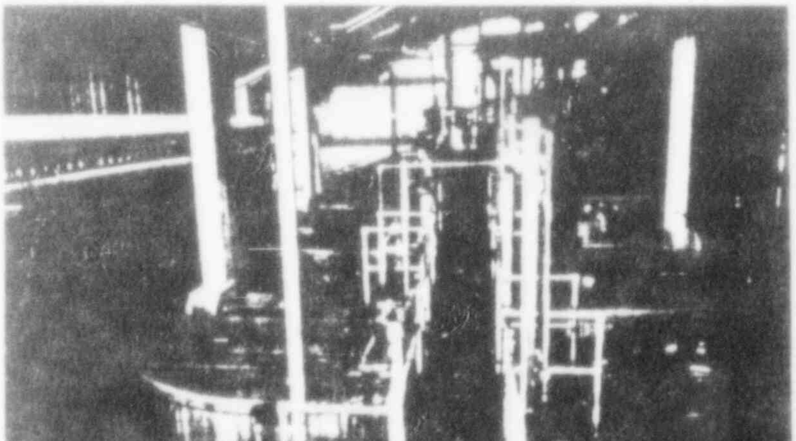
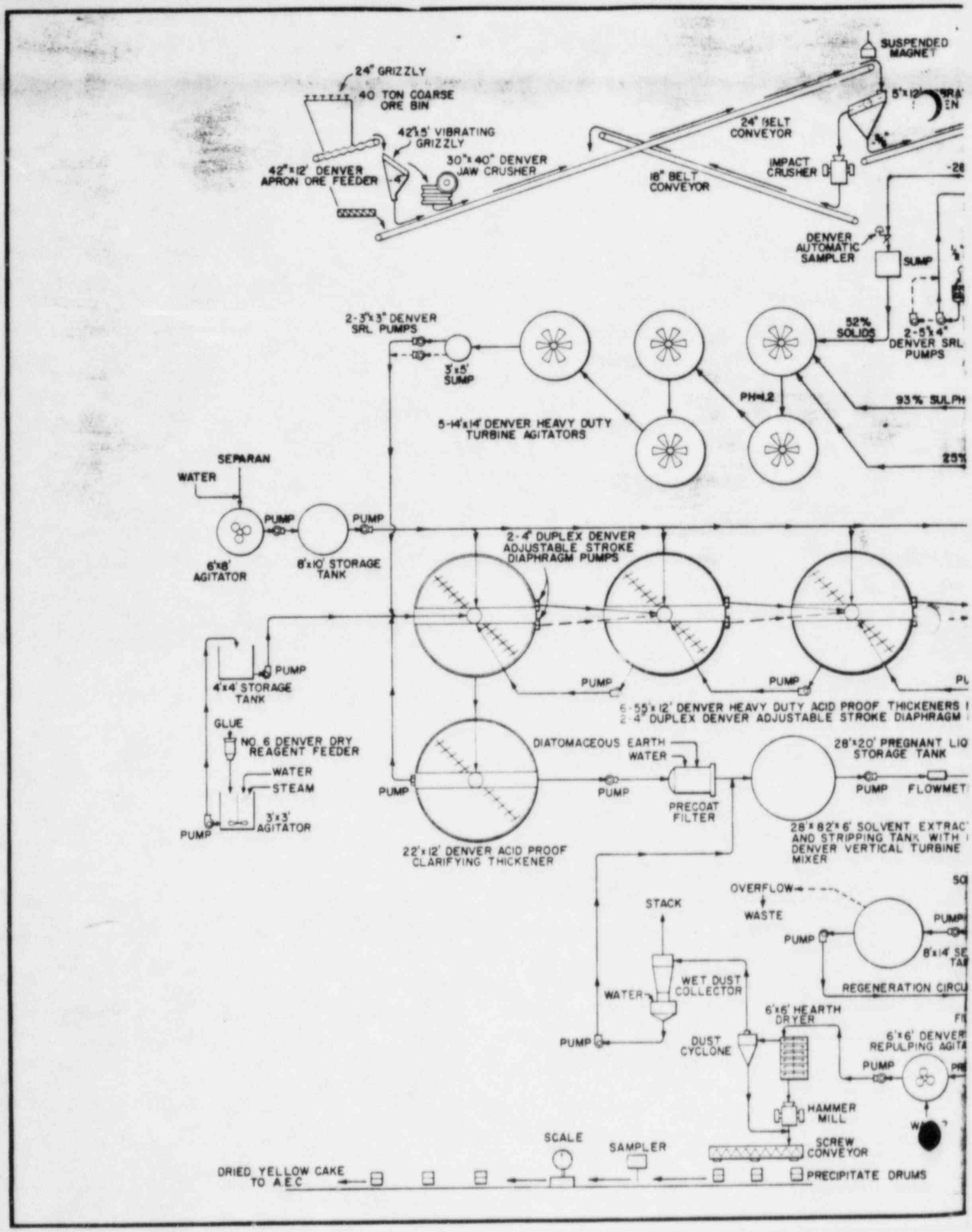
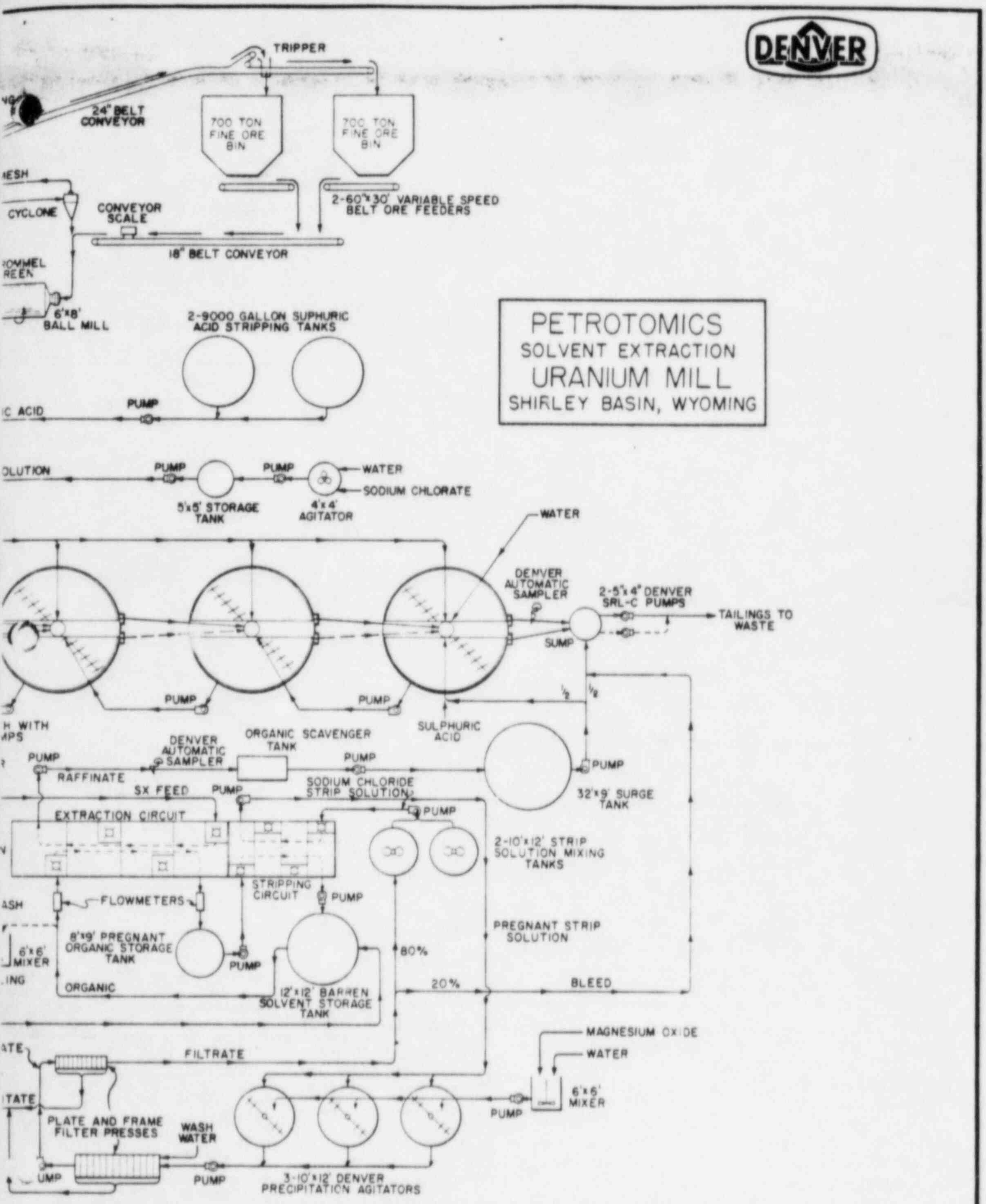
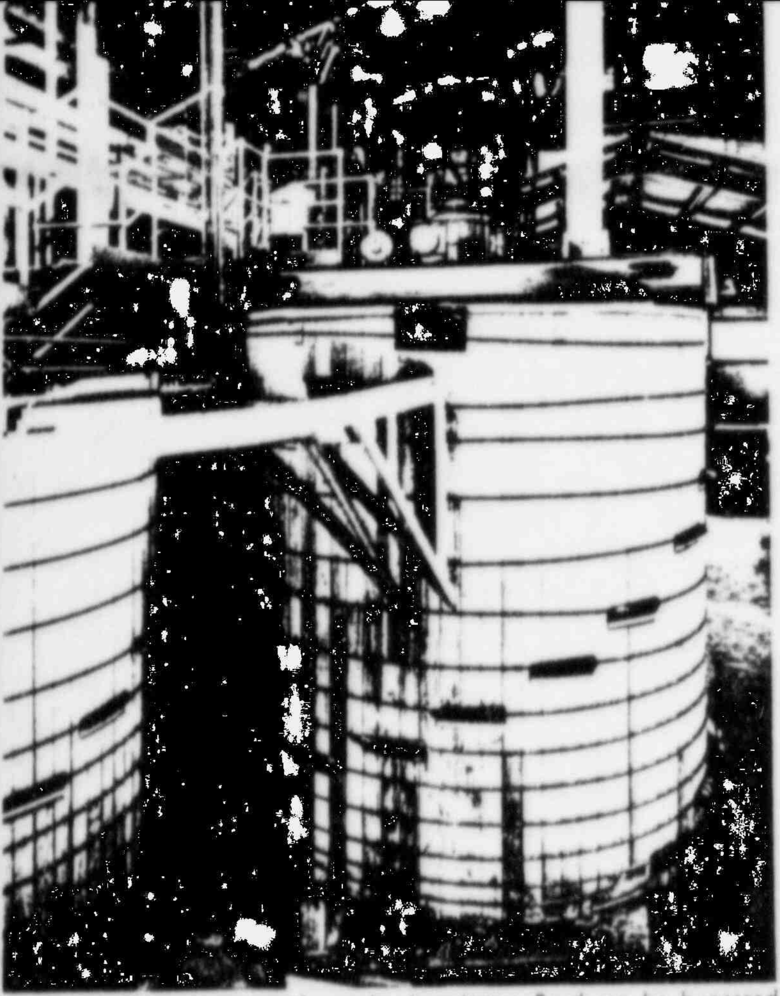



24" GRIZZLY
40 TON COARSE ORE BIN
42"x12' DENVER APRON ORE FEEDER
42"x5' VIBRATING GRIZZLY
4"
30"x40" DENVER JAW CRUSHER
24" BELT CONVEYOR
18" BELT CONVEYOR
SUSPENDED MAGNET
5'x12'
IMPACT CRUSHER
-28
DENVER AUTOMATIC SAMPLER
SUMP
52% SOLIDS
2-5"x4" DENVER SRL PUMPS
2-3"x3" DENVER SRL PUMPS
3'x5' SUMP
PH=1.2
93% SULPH
25%
5-14'x14' DENVER HEAVY DUTY TURBINE AGITATORS
SEPARAN
WATER
PUMP
PUMP
6'x8' AGITATOR
8'x10' STORAGE TANK
2-4" DUPLEX DENVER ADJUSTABLE STROKE DIAPHRAGM PUMPS
PUMP
4'x4' STORAGE TANK
PUMP
PUMP
PL
6-55'x12' DENVER HEAVY DUTY ACID PROOF THICKENERS
2-4" DUPLEX DENVER ADJUSTABLE STROKE DIAPHRAGM
GLUE
NO 6 DENVER DRY REAGENT FEEDER
WATER
STEAM
3'x3' AGITATOR
PUMP
PUMP
22'x12' DENVER ACID PROOF CLARIFYING THICKENER
DIATOMACEOUS EARTH
WATER
PUMP
PRECOAT FILTER
28'x20' PREGNANT LIQ
STORAGE TANK
PUMP
FLOWMET
28'x82'x6' SOLVENT EXTRAC
AND STRIPPING TANK WITH
DENVER VERTICAL TURBINE
MIXER
SO
OVERFLOW
WASTE
PUMP
PUMP
8'x14' SE
TA
REGENERATION CIRCU
STACK
WET DUST COLLECTOR
WATER
PUMP
FI
6'x6' HEARTH DRYER
DUST CYCLONE
6'x6' DENVER
REPULPING AGITA
PUMP
PR
HAMMER MILL
W
SCREW CONVEYOR
SCALE
SAMPLER
PRECIPITATE DRUMS
DRIED YELLOW CAKE TO A.E.C.



PETROTOMICS
SOLVENT EXTRACTION
URANIUM MILL
SHIRLEY BASIN, WYOMING



Close-up view of one leach agitator. Feed can be bypassed from any agitator without disturbing the circuit during inspection or maintenance periods. The agitators are equipped with rubber covered shafts attached to 54" diameter, 150% pitch, six bladed, rubber covered DENVER Turbine Propellers.

rubber covered shafts attached to 54" diameter, 150% pitch, six bladed, rubber covered Denver Turbine Propellers. The propellers are attached to the shafts by means of an acme thread. Each agitator has a 20-HP motor. Wood tanks have 4" nominal staves and bottoms.

The agitators are arranged so that the feed can be bypassed from any unit without disturbing the circuit during inspection or maintenance periods. An automatic pH recorder and controller is provided for regulation of optimum dissolution conditions. In excess of 97.0% of the contained uranium is dissolved in the agitators.

Countercurrent Decantation Washing

The discharge from the leaching circuit is delivered to the countercurrent decantation washing system using a 3" x 3" Denver SRL Pump. A second identical pump is installed for standby service. The washing system consists of six 55' diameter by 12' deep Denver Heavy Duty Acid Proof Thickeners. The thickeners operate at approximately 19% solids at a pH of 1.5. Each thickener is equipped with two 4" duplex Denver Adjustable Stroke Diaphragm Pumps (one for standby) for advancing the thickener underflows at approximately 55% solids. Approximately 100-GPM of fresh water and 100-GPM of raffinate solution from the solvent extraction system are added as wash solution to the last thickener and overflowed into 180-degree launders. The pregnant liquor overflowing No. 1 thickener contains approximately 1.5-grams U_3O_8 per liter.

The thickener tanks are constructed of 4" nominal thickness wood staves. The shafts, rake arms and tie rods are rubber covered and driven by a 60" enclosed running-in-oil Denver Mechanism mounted on beam-type superstructures. Superstructures were fabricated and shipped in one piece to reduce installation costs. The rake blades and all wetted hardware are of 316 stainless steel. The Denver Diaphragm Pumps have rubber lined bowls, rubber valve seats and lead impregnated ball valves. Experimental work is being conducted in the use of ceramic ball valves and results look favorable. Metal parts in contact with the acid pulp are of 316 stainless steel.

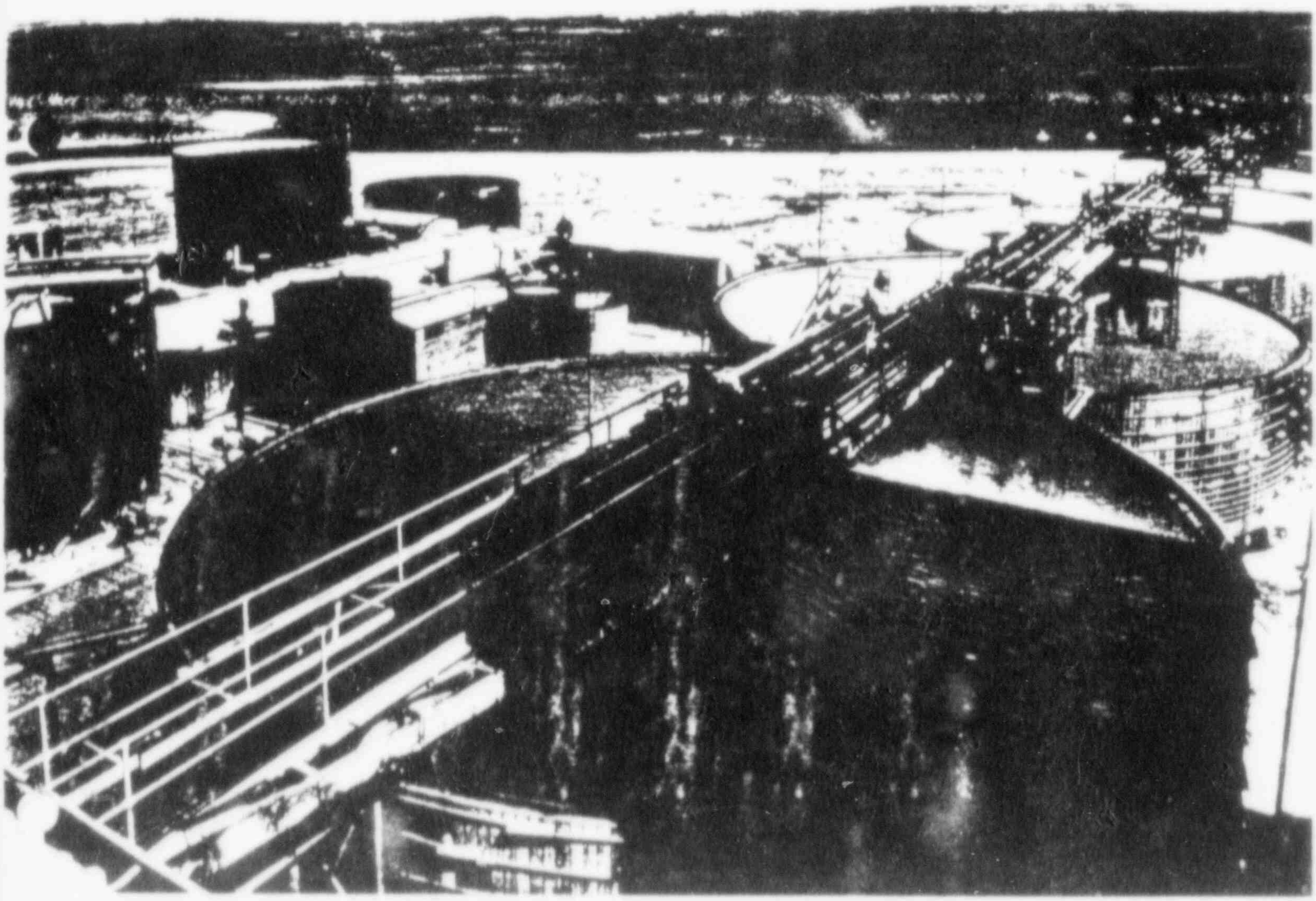
Separan NP-10 and glue are added to the thickeners as flocculants in quantities of 0.05 and 0.04 pounds per ton of solids, respectively. The Separan is prepared as a 0.25% solution. The glue is prepared as a 1.0% solution in a 3' x 3' agitator using a No. 6 Denver Dry Reagent Feeder to slowly add the dry glue powder to the agitator. The only steam employed in the plant is used in preparing the glue solution.

Clarification of Pregnant Liquor

The pregnant liquor from the No. 1 thickener is further clarified in a 22' diameter by 12' deep Denver Acid Proof Clarifying Thickener. The shaft and rake assembly are rubber covered and tank is of 3" wood construction. The underflow is returned to the feed well of the No. 1 washing thickener. The overflow from the clarifying thickener is pumped to a 400-square-foot precoat filter for final clarification and stored in a 28' diameter by 20' deep tank preparatory to solvent extraction.

The washed underflow solids (tailings) from No. 6 thickener are sampled using a Denver Automatic Sampler and then pumped through a 6" wood pipe to the tailing pond approximately 1600-feet away. Two 5" x 4" Denver SRL-C Pumps (one standby) are used to pump the tailings. The portion of non-cycled raffinate and bleed from the filtration circuit are added to the tailing pump sump and discarded.

No. 10 DENVER Worm-Gear Reducers with flanged connection to agitator shafts are used. Each agitator has a 20 HP motor. Agitators are designed to start up under full load.



[illegible]

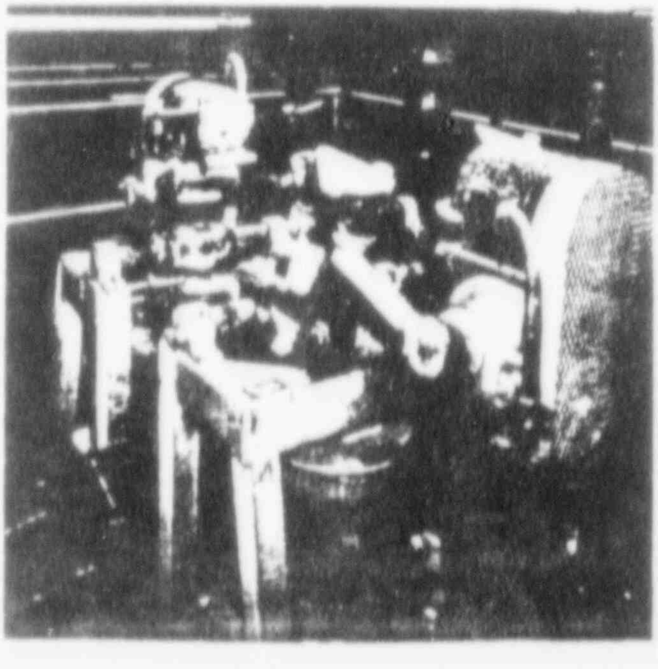
Solvent Extraction and Stripping

The [illegible] [illegible] industry has lead the way in developing and [illegible] the [illegible] that solvent extraction [illegible] [illegible] and [illegible] applied to the [illegible] and [illegible] products.

The pregnant leach solution is pumped through a [illegible] and then to the solvent extraction circuit. This consists of four extraction stages and four stripping stages which are all accommodated in a compartmented rectangular shaped tank measuring [illegible] wide by [illegible] long by [illegible] high. The tank is constructed of reinforced concrete lined with [illegible] for protection from the acidic solutions. [illegible] and PVC piping were also provided between each stage of the compartment. The settling compartments [illegible] [illegible] [illegible] of the extraction [illegible].

The countercurrent flow of [illegible] and [illegible] of the extraction [illegible] is [illegible] using Denver Solvent Extraction Pumping [illegible] constructed of 316 stainless steel. [illegible] [illegible] are [illegible] [illegible] the extraction stages [illegible] of the [illegible] of the aqueous and organic [illegible]. The flow through the extraction stages is approximately

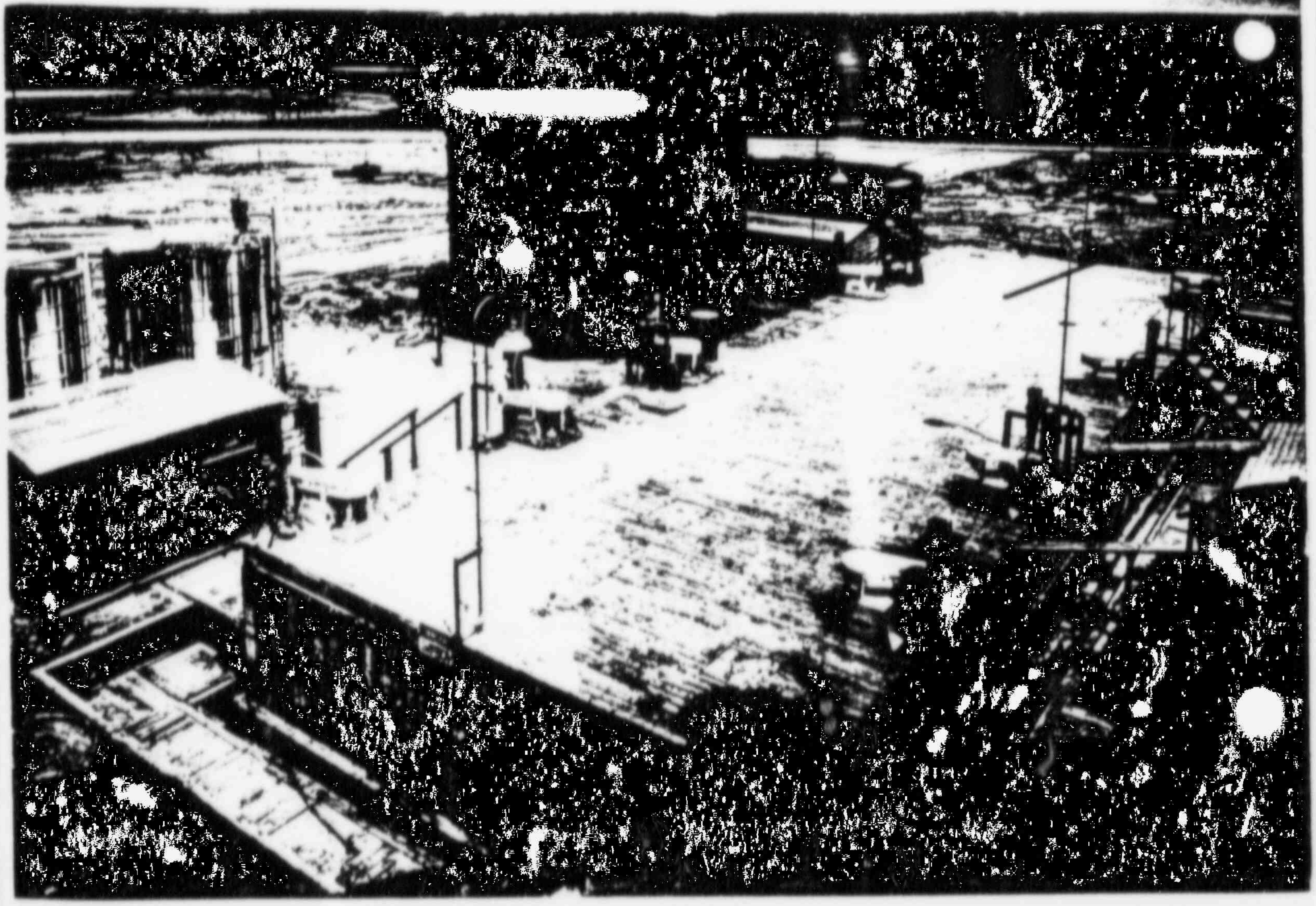
[illegible]

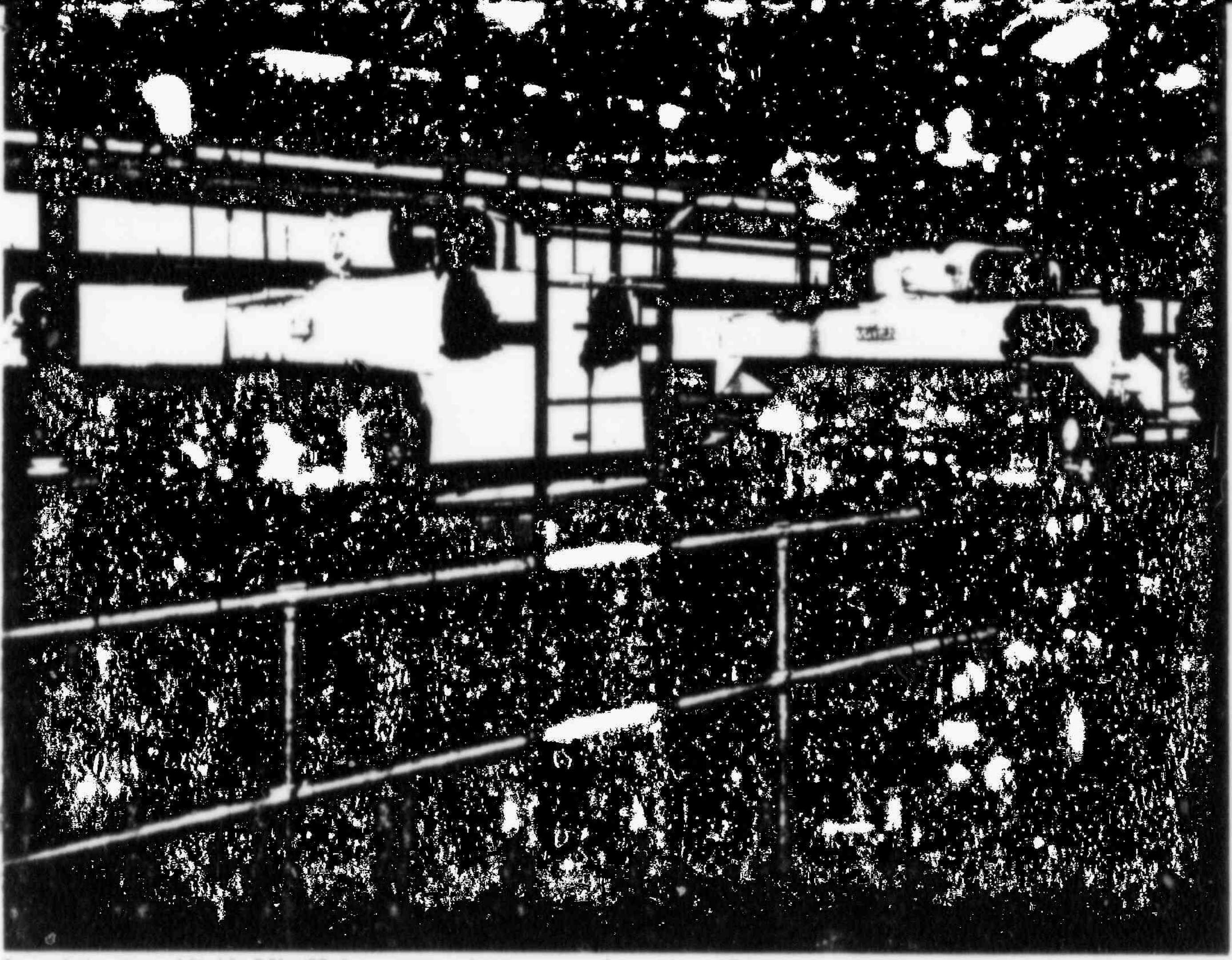


The overflow from the No. 1 thickener (pregnant liquor) is clarified in the 22' diameter by 12' deep DENVER Acid Proof Clarifying Thickener. The underflow is returned to the feed well of the No. 1 washing thickener. Overflow is pumped to storage and then to solvent-extraction.

Close up view of the 28' wide by 82' long by 6' high compartmented solvent extraction and stripping unit. The DENVER Solvent-Extraction units incorporate a counter-current flow principle which is accomplished without the customary acid-proof piping and pumps.

Overall view of the solvent extraction and stripping unit. The pregnant leach liquor after passing through a precoat filter is treated by solvent extraction. The countercurrent flow of aqueous and organic is accomplished using DENVER Solvent Extraction Pumping Turbines. Recovery of uranium from the pregnant leach solution by solvent extraction is in excess of 99%.





Two of the three 10'x12' DENVER Precipitation Agitators are shown here. Filling, precipitation, and discharging is alternately employed for each agitator. Magnesium oxide is used to precipitate the uranium. Two slowly revolving wood paddles attached to a wood shaft by means of 316 stainless steel fittings provide the gentle action required for ideal precipitation conditions.

200-GPM of pregnant leach liquor having a pH of 1.5 and containing approximately 1.5-grams of U_3O_8 per liter. The organic solution consists of a mixture of 2.5% Alamine 336, 2.0% Isodecanol and 95.5% kerosene.

The raffinate (spent leach solution) is sampled with a Denver Automatic Sampler and after passing through an organic scavenging tank is split so that one-half is used for solution back wash in the countercurrent decantation circuit and the other one-half is discarded with the tailings.

The pregnant organic solution contains approximately 2.5-grams of U_3O_8 per liter and represents a flow of 160-GPM. This solution enters the stripping circuit and is contacted with 1.5N sodium chloride solution strip solution having a pH of 1.5 with sulphuric acid.

Recovery of contained uranium from the pregnant leach solution by solvent extraction is in excess of 99%. The mixer-settler units used in stripping are of the same design principle as the extraction units. The Denver Mixing-Pumping Turbines and shafts, however, are constructed of mild steel covered with 1/8" paraline. The barren organic solution is returned to a 12' x 12' storage tank and reused in the extraction circuit.

Provision was made to regenerate the organic solution for removal of molybdenum but to date the content of molybdenum has been so low that regeneration has not been necessary. Nevertheless, this safeguard is available whenever required.

Chemical consumptions are shown in Table II.

Precipitation and Filtration

The pregnant strip solution containing 30-40 grams of U_3O_8 per liter and representing a flow of approximately 9.5-GPM is pumped to one of three 10' x 12' Denver Precipitation Agitators. Magnesium oxide is added to a pH of 7.0 to precipitate the uranium. The precipitation agitators are equipped with two slowly revolving paddles. The shaft and paddles are of wood construction with 316 stainless steel fittings. The tanks are of wood and equipped with baffles. Filling, precipitation, and discharging is alternately employed for each agitator.

The precipitated slurry is pumped to a filter press where the yellow cake is filtered and water washed. The filtrate is refiltered in a second filter press to insure complete recovery of the solids. The final filtrate is split so that approximately 20% is bled to waste and 80% is returned to the strip solution make-up tanks.

The raffinate is sampled with a DENVER Automatic Sampler ahead of the organic scavenging tank. One half of the raffinate is discarded and the other one-half is used for solution back wash in the washing thickeners.

The washed tailings and waste solutions are pumped to the tailings pond using two 5"x4" DENVER SRL-C Pumps. One pump is employed for standby duty. Tailing pond is approximately 1600-feet away.

Drying and Packaging

The filtered yellow cake is repulped with water in a 6′ x 6′ Denver Vertical Turbine Agitator designed with an oversize turbine operated at slow speed to avoid breaking down the precipitate. It is pumped to a 6′ diameter by 6 hearth dryer. Vangas is used for fuel. The dried yellow cake is discharged by gravity through a small hammermill to break-up any lumps and then to a screw conveyor. Three discharge spouts are provided in the screw conveyor to automatically fill a concentrate drum and signal when it has been filled.

The exhaust from the dryer passes through a dry cyclone which removes some yellow cake and discharges into the screw conveyor. The remaining dust is removed in a wet dust collector and the slurry is pumped to the clarified pregnant liquor storage tank where the yellow cake is immediately dissolved and reprocessed through the solvent extraction system.

The drying and packaging are conducted in enclosed areas within the mill building to avoid any possible contamination of the working areas.

The drums of yellow cake are sampled, weighed, stenciled, and shipped to the Atomic Energy Commission at Grand Junction, Colorado. The yellow cake assays 88 to 89% U_3O_8.

Laboratory

A complete chemical laboratory is available at the mill for making all assays on ores, solutions and final yellow cake product. A metallurgical laboratory is also available for plant control studies.

Acknowledgment

Denver Equipment Company wishes to thank Petrotomics Company for permission to describe their Shirley Basin Uranium Operation. Special thanks are extended to Mr. Norman A. Grant, Project Manager; Mr. G. K. Coates, Mill Superintendent; and Mr. Emmerson Kemp, Metallurgist and General Foreman, for their assistance in providing the information for this article. We also would like to thank Stearns-Roger Manufacturing Company for their cooperation in supplying the excellent photographs shown in this mill description.

TABLE I

MILL PERSONNEL

	Number
Mill Superintendent	1
Metallurgist—General Foreman	1
Chief Chemist	1
Maintenance Foreman	1
Shift Bosses (one per shift)	4
Analytical Laboratory Technicians	3
Crushing	2
Mill Operators (four per shift)	16
Helpers (one per shift)	4
Mill Laborer (day shift only)	1
Mechanics	4
Mechanic Helpers	2
TOTAL	40

Crushing crew consists of two men.
Maintenance consists of two crews comprised of two mechanics and one helper overlapping to cover the week. All are on duty on Wednesday and consequently this is the major maintenance day.

TABLE II

CHEMICAL CONSUMPTION

	Range Pounds per ton
Sulphuric Acid, 93% strength	60.00 -90.00
Sodium Chlorate	2.00 - 2.25
Sodium Chloride	15.00 -20.00
Magnesium Oxide	1.20 - 1.60
Kerosene	0.10 - 0.20
Alamine 336	.004- .008
Isodecanol	.005- .009
Glue	.40 - .06
Separan NP-10	.05 - .09
Filter Precoat Compounds	.45 - .60

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