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PILOT PLANTS SECTION REPORT FOR AUGUST, SEPTEMBER, 1949

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ORNL-490
Chemistry-Separation
Processes for Plutonium
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TECHNICAL DIVISION

OAK RIDGE NATIONAL LABORATORY

CHEMICAL TECHNOLOGY DEPARTMENT

PILOT PLANTS SECTION REPORT FOR AUGUST AND SEPTEMBER, 1949

D. G. Reid

DATE ISSUED
DEC 27 1949

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ORNL 490
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ABSTRACT

Decontamination studies conducted in the ORNL 205 Building Pilot Plant on equipment that had processed Hanford production material indicate that process vessels and lines can be adequately decontaminated within a reasonable length of time to permit the use of direct maintenance procedures. This can be done by the use of steam, nitric acid, sodium hydroxide and chemical solutions having a reducing action on the passivated surface of the stainless steel process equipment.

The equipment modifications, chemistry investigations, and operational changes are sufficiently complete to permit the processing starting about October 15, 1949, of the Hanford irradiated U^{235}/Al alloy. The aim of this operation is to prove the process for recovering the unspent U^{235} from the Materials Testing Reactor discharged fuel assemblies.

The formation of the group for operating the 23 Pilot Plant has begun and the necessary preparation and planning started.

The next periodic report by the Pilot Plant Section will cover the 25 recovery tests which will be conducted during October and November, 1949.

[redacted]

[redacted]

[redacted]

"25" RECOVERY PILOT PLANT DEVELOPMENT

Technical - Rigstad, Rom, Harrington, Hylton, Landry, Nicholson, Shank, Stewart, (full time) Kennedy, Sadowski (part time)

Non-Technical - Beeler, Benson, Burnett, Gifford, Grizzell, Groover, Jennings, Land, Ledbetter, Lockmiller, McLellan, Sexton, Shields, Shipwash, Spangler, Summers, Thomas, Thompson, Wiggins

I. SUMMARY

The Pilot Plant equipment used in the Redox investigations has undergone a series of rigorous treatments to reduce fission product and plutonium activity levels.

At the completion of this extensive decontamination all process and service equipment was inspected and the repairs and modifications started that were necessary to insure the successful processing of the HEW irradiated U^{235}/Al alloy for verifying the Materials Testing Reactor recovery process. The equipment flowsheet to be used in this processing is given on the last page of this report, Drawing 7819.

Concurrent with plant overhaul all operating and fissionable material accounting procedures were reviewed and revised where necessary.

II. EQUIPMENT DECONTAMINATION - E. C. Stewart

Alterations required to place the operating equipment of the ORNL Hot Pilot Plant in service for "25" processing necessitated decontamination of the equipment utilized for the Redox investigation, which had been carried out at full Hanford radiation level. Thorough decontamination was mandatory because the necessary alterations required direct maintenance procedures. In addition, the removal of all natural uranium from the system was necessary to prevent cross contamination of the "25" to be processed.

Decontamination of the equipment was accomplished by heating and circulating various chemical solutions through the process vessels. All samples were analyzed for gross beta and gamma with some being analyzed for alpha, Ru, Zr and Cb. The radiochemical analytical data was inconclusive because the decontamination processing resulted in a large number of the solutions being

[redacted]

Equipment Decontamination (Continued)

either almost gelatinous or containing particulate matter making representative analysis difficult because of their heterogeneity.

The columns were decontaminated by pumping a series of solutions through the columns and sampling the exit solution via the raffinate sampler every hour. The decontaminating solutions were passed thru the columns until eight hours working time was available or until radiation from adjacent equipment gave equal or higher readings.

From the observations made during the decontamination of the Dissolver (A1), Feed Adjustment Tank, (A4), Filtrate Catch Tank, (A12), First Cycle Extraction Column (B1) and the Redox U-Pu Separation Column (1B), it is felt that the removal of activity of the equipment took place by three methods; solution or complexing of the activity, abrasion, and corrosion of the equipment. Table I classifies the action of different materials and procedures used during this decontamination. Reducing solutions capable of removing the passivated surface of the stainless steel vessels were considered as corrosion chemicals.

These solutions gave varying results. A solution of 50% caustic and 11-15% citric acid by weight was not as effective as either of the solutions used independently. A solution of 20% HNO_3 plus 1/2% NH_4F-HF removed the same amount of beta material as a 1% NH_4F-HF solution but a factor of seven times as much gamma. Compared with other solutions it was found that solutions of less strength than 55% nitric or 50% sodium hydroxide were far inferior to reducing solutions of acidic citrates, oxalates or fluorides of any strength.

A list of solutions for possible use in decontaminating stainless steel process vessels and piping as well as packed columns without excessive corrosion are given below. After treatment with these solutions the stainless should be repassivated with 70% nitric acid at 85-100° C for two hours.

1. Free high pressure steam applied as liberally as safely possible followed by a water wash.

2. Oxalic acid - 5% and 2% solutions at 100° C.

3. Citric acid - 3% and 1% solutions at 100° C.

4. Ammonium bifluoride 1 or 2% at not over 60° C or more than 1/2 hour.

5. Ammonium fluosilicate - 4% plus 5% HNO_3 at 100° C for less than 1 hour.

6. Sodium hydroxide - 30% plus 10% citric acid at 100° C.

[redacted]

TABLE I

Classification of Decontaminating Materials

	Abrasion	Solution or Complexing	Corrosion
Water - agitated		X	
Water - boiling		X	
Water - steam sparged	X	X	
Free Steam	X		
Nitric Acid - agitated		X	
Nitric Acid - boiling		X	X
Nitric Acid - steam sparge - 125° C		X	X
HF solution - agitated - 60° C			X
HF solution - heated		X	X
Sodium hydroxide agitated		X	
Sodium hydroxide steam sparged - 100° C		X	
Citric acid - agitated		X	X
Citric acid - heated 100° C		X	X
Oxalic acid - agitated		X	X
Oxalic acid - heated - 100° C		X	X
Ammonium fluosilicate agitated		X	
Ammonium fluosilicate plus HNO_3 agitated		X	X
Ammonium fluosilicate plus HNO_3 - 85° C		X	X
Sodium hydroxide plus citric acid		X	X

[redacted]

Equipment Decontamination (Continued)

The use of 1-2% ammonium bifluoride at room temperature is excellent in maintaining clean stainless equipment. This solution will readily remove all stains except those of grease origin and can be applied over a tank surface with a rag.

More detailed discussion of these results as well as the information in Section III will be given in a formal report scheduled for issuance during November, 1949.

III. EQUIPMENT SURVEY SUMMARY - Nicholson, Stewart

A survey of process equipment revealed no justification of any major alterations in equipment specifications, except possibly welding techniques, for either long or short lived installations. Supplementary service equipment and structural members, however, should be installed with consideration as to material used or coatings applied to avoid serious decontamination problems.

A. General Structural Survey

The external appearance of all cell equipment showed satisfactory service for short term use. Observations made are as follows:

1. Black iron retains excessive contamination, when subject to spills, especially in structural cracks.

2. Glyptal resin covered, black iron will retain activity in the chalky surface, which appears after a period of service.

3. All cell surfaces and electrical instruments should be designed for 100% humidity atmosphere or saturated steam conditions.

4. All concrete surfaces should be covered with a light-reflecting impervious coating.

5. The life of electrical motors, agitator gear boxes, and couplings can be extended indefinitely by encasing in a continuously air purified housing to eliminate corrosive fumes and contamination.

Equipment Survey Summary (Continued)

B. Process Vessel Survey

All processing equipment was in excellent condition; however, replacement of some of the dissolver dip tubes was desirable. Suggestions and observations are as follows:

1. Vessels fabricated from cold rolled plate are more readily decontaminated than those from hot rolled plate.

2. Double passes should be made on all resistance welds.

3. Shielded-arc fusion welding may be superior to regular resistance welding practices.

4. Seamless tubing and pipe are superior in corrosion resistance and ease of decontamination to butt welded pipe.

5. Teflon gaskets were found to be superior to polythene gaskets for process solutions, both structurally and chemically.

6. Raschig rings manufactured from cold rolled sheet are more easily decontaminated than those cut from pipe.

Detailed observations from which the above conclusions are obtained will be published in a formal report scheduled for issuance during November, 1949.

IV. PLANT OVERHAUL AND CONVERSION - Nicholson

Maintenance work on the conversion of the Pilot Plant from Redox to the 25 recovery process is estimated to be approximately 85% complete and is scheduled for completion by October 15, 1949. Work in Cell I was impeded by the short working time caused by deep seated contamination of the concrete and structural steel surfaces.

The modifications made during this conversion in addition to the cleansing from natural uranium are listed in the Appendix.

V. 25 PROCESS CHEMISTRY - Rom

The process for dissolving U/Al alloy slugs developed by the Semi-Works has been successfully adapted to the Pilot Plant dissolver as evidenced by the full scale dissolvings made recently with unirradiated natural U/Al alloy. This dissolver solution plus the $Al(NO_3)_3$ butt was satisfactorily clarified after passing through the Pilot Plant feed filtration equipment.

It was possible to dissolve about 95% of an 8 Kg. batch of U/Al alloy by first adding 2% by weight of $Hg(NO_3)_3$ as catalyst and then 3.75 moles of 70% HNO_3 per mole of aluminum over a 14 hour period followed by a 10 hour digestion. Simultaneously with the acid addition, the temperature was gradually increased from 85° C to a maximum of 103° C. A "follow-up" dissolving using 10% of the original amount of HNO_3 and $Hg(NO_3)_2$ succeeded in putting into solution the remaining portion of the original 8 Kg. as shown by a visual inspection of the dissolver at the completion of two dissolvings. The final mixture of dissolver solutions was approximately 60 gallons in volume, 1.4 M in $Al(NO_3)_3$, and from .05 to .70 N HNO_3. Since the Pilot Plant process flowsheet calls for a 120 gallon feed volume, this method allows 60 gallons for $Al(NO_3)_3$ butting and chemical adjustments during feed preparation.

The addition of aluminum silicon alloy to simulate the Al/Si bonding material which will be present in the irradiated, enriched slugs resulted in a dark, turbid raw feed solution. The crud containing U/Al dissolver solution was passed through a G porosity (10 micron) sintered stainless steel filter disk in a reasonable length of time and yielded a solution which appeared only slightly cloudy. The crud collected on the sintered stainless steel filter disk had a very dark appearance and was composed of very fine crystals. A spectrographic analysis showed it to be mainly aluminum and silicon. When the crud was washed in place with a small amount of HNO_3 and water, the uranium loss incurred amounted to less than 0.01% of the total uranium filtered. The filter plate was satisfactorily cleansed by the same procedure used in the past 25 work.

Tests by the Semi-Works section on a 6 ft. long by 3 in. diameter column packed with 1/4 x 3/8" split rings operating only as a simple extraction column (without scrub) showed that the processing of raw unfiltered dissolver solution through the Pilot Plant columns was possible for short periods of time. During the week-long tests, Pilot Plant dissolver solution was recirculated through the column. No operating difficulties such as column plugging were encountered, and although the column was stagnant for eight hours a day no trouble was had in resuming operation. Most of the solid material passed out with the aqueous raffinate although a small amount was seen in the hexone. Some of the black, siliceous material remained on the packing but no interference with flow rates or column plugging was observed.

The flowsheet to be used in column operation and product concentration is given in Fig. I. No attempt will be made to recover the various transuranics present in the first cycle feed.

[redacted]

Drawing # 7872

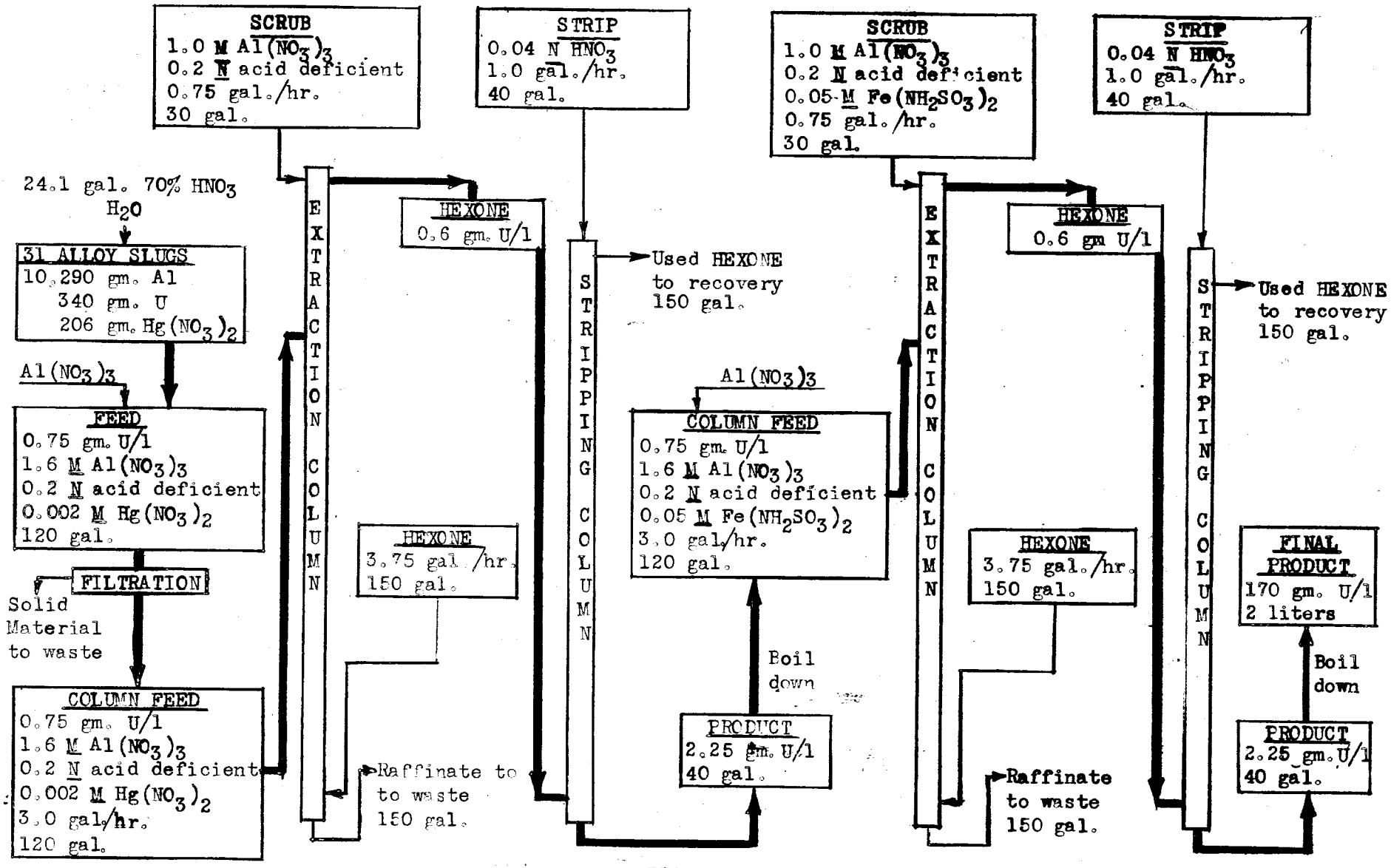


FIGURE I

"25" PILOT PLANT FLOWSHEET FOR ENRICHED MATERIAL
10-1-49

[redacted]

VI. 25 OPERATIONAL PROCEDURES - Kennedy and Rigstad

Processing of HEW irradiated uranium of high U^{235} enrichment for 1200 Area process verification will necessitate strict uranium accountability and security measures. The procedures to be in effect have been reviewed and approved by the ORNL SF Accountability Office and Security Office and are summarized in the memo, C.F. #49-9-215. In brief, the procedures are as followed:

(1) The 217 irradiated U/Al alloy slugs will be processed in seven batches of 31 slugs, each batch containing approximately 340 gms. of enriched U^{235} and 10.3 Kg. of Al.

(2) After each processing step, sufficient samples will be assayed for uranium for SF Accountability and process efficiency before going on with the next operation.

The weights of uranium now charged on the SF Accountability records is based on averages from the Metallurgy batches and does not take into account any fission loss. The fission loss is estimated roughly as 15 grams of U^{235} per batch of 31 slugs.

VII. 25 PROGRAM - Rigstad

Dummy runs for equipment checking are scheduled to start on October 6, 1949 and processing of the U^{235}-Al alloy will start approximately one week later and continue for six weeks.

The material will be processed through two solvent extraction cycles with close control on all waste solutions to insure against excessive losses of U^{235}. The second cycle product solution will be evaporated to a volume that can be handled in the laboratory and after careful assay will be transferred to the Laboratory Section for purification and further concentration.

Appreciable amounts of U^{236}, presently in demand for physical measurements, will be present in the product uranium. Upon completion of the laboratory processing the material will be sent to Y-12 for isotopic separation.

[redacted]

"23" PILOT PLANT DEVELOPMENT

Technical - Klotzbach (full time), Jackson, Ferguson, Lewis (part time)

Non-Technical - Gifford, Jones, Summers (part time)

VIII. INTRODUCTION

By early 1948 a solvent extraction process for the recovery of U^{233} from irradiated thorium had been developed in the laboratory by the Chemistry and Technical Divisions at ORNL. In order to obtain engineering data necessary for the design of a plant to recover U^{233} produced in the Materials Testing Reactor, a 23 Pilot Plant was designed and constructed in Bldg. 706-HB during 1948 and 1949.

The general features of the 23 Pilot Plant are very similar to the Pilot Plant used for the 25 and Redox investigations at ORNL, except that equipment capacity has been reduced by a factor of about five. Process tanks have a capacity of 30 to 100 gallons, and 1 1/2" packed columns are used. Shielded equipment for only one cycle of extraction, scrubbing and stripping is required for the 23 process.

IX. PROGRAM

A 23 Pilot Plant Group is currently being organized. The testing and calibration of equipment, training of operators, and other startup operations will proceed on a low priority basis until the completion of the 25 Pilot Plant Program, at which time the full compliment of 8 Technical men and 12 Operators will be assigned to the group. Functions of the group will include supervision, planning, analysis of data, preparation of all 23 process reports, and operation of the 23 Pilot Plant on a 24 hour, 7 day week basis.

There is available for the 23 program 740 kg. of thorium metal which has been irradiated for four months at Hanford, and cooled from six to twenty months. Twenty-five hot runs will be made over a 3-4 month period beginning about December 15, 1949. Approximately 280 grams of U^{233} will be separated

[redacted]

[redacted]

MISCELLANEOUS

X. REDOX - Jackson, Sadowski (part time)

The formal report for the Redox Pilot Plant investigations, ORNL-463, is completed through the rough draft stage and is scheduled for issuance in the coming period.

The advantages of recovering, in the near future, the plutonium separated during the Redox investigations, versus storage and processing of its material by the Hanford production plant are being determined.

XI. WASTE DISPOSAL

There has been no progress in the past period but this program will be reactivated in the coming period.

XII. EQUIPMENT DEVELOPMENT - Nicholson

25 Product Evaporator Development

Inadequate laboratory facilities for handling a large volume of 25 solution make it desirable to concentrate the second cycle product solution before transfer to the laboratory. The original plan to do this in a small, inclined tube evaporator with continuous feed from the column stream and continuous product discharge was abandoned because, during testing of such an evaporator, it was shown that the desired low product rate of 1-2 cc/min was difficult to maintain, without risking overheating and possible failure of the "Calrod" electrical heaters and the external tubes.

[redacted]

Equipment Development (Continued)

The electrically heated continuous product evaporator was replaced by a small, steam heated, conical tank which will also be fed continuously from the column but will concentrate and retain all the 25 until the run is concluded. This evaporator is installed in Cell 3 and is provided with liquid level and specific gravity measuring instruments, feed and condensate rotameters, thermocouples, and a baffled entrainment removal head. Supplementary equipment and instrumentation also installed in Cell 3 includes a catch tank for the product solution from the column in case of evaporator failure and two condensate catch tanks. All the equipment is arranged for direct operation. Nomenclature for the new equipment is as follows:

1. P1 Product Catch Tank
2. P2 Product Evaporator
3. P3 Condensate Catch Tank
4. P4 Condensate Catch Tank
5. P5, P6, P7 Product Receiver Bottles (in a Carrier Can)
6. P10 Condenser

Both the continuous and batch evaporators were tested by concentrating a solution of sodium dichromate and analyzing the condensate for chromium. Chromium in the condensate was found to be less than the detectable amount and the upper limit of loss from the concentration step is estimated to be 0.08%. If the U loss in actual operation approaches this upper limit, it can be reduced by re-evaporating the condensate.

XIII. 807 PATROL - Purkey, Caldwell, Davis, Strader (full time), Gifford, Jones (part time)

Operation of the demineralization building and miscellaneous patrol services have been performed without incident.

All instruments in the building with the exception of the pH controller for the water to the pile Mock-Up have been overhauled and put in acceptable working condition. Work on the pH controller is continuing and it is expected to be completed next month.

The rough draft of the Operations Manual for the 807 Bldg. is approximately 80% complete and is expected to be issued shortly. Transfer of the responsibility of operating the demineralization building from the Pilot Plant Section to the Operations Division is scheduled to occur on or about January 1, 1950.

Operating Summary 8/1 - 9/31/49

Total filtered water to Bldg.	1,998.900 gallons
Demineralized water to	
Bldg. 105	927,000 gallons
Bldg. 101 & 807	92,000 gallons
Bldg. 205	22,100 gallons
Bldg. Mock-Up	398,900 gallons
TOTAL	1,430,000 gallons
Operating Efficiency	71.5%
Ave. pH Demineralized H_2O	4.7
Ave. Resistance Demineralized H_2O	148,000 ohms.

XIV. GENERAL ADMINISTRATIVE

The first checking of the architectural drawings covering the permanentization of the 205 Building has been completed.

A formal report, ORNL-466, entitled "Recommendations for Design of Radioactive Solvent Extraction Units" by D. G. Reid has been issued in the past period.

L. L. Fairchild, Chief Research Operator, was transferred to the Chemical Engineering Department as Technician on September 19, 1949.

A 5 cc sample of the IAW stream from Redox Run 52 was sent to ANL.

[redacted]

APPENDIX

A summary of the equipment modifications made to the 205 Bldg. Pilot Plant is as follows:

1. The Dissolver and Reflux Condenser (A1 and A2) were sufficiently decontaminated to permit removal from the cell and inspection by direct means. They were found to be in satisfactory condition after the deposit of NH_4NO_3 and SiO_2 on the A2 Condenser coils was washed off. Both pieces of equipment were reassembled with new gaskets and no modifications other than the replacement of some of the badly corroded 347 stainless steel, butt welded pipe dip tubes by type 309 SCb stainless steel seamless tubing dip tubes.

2. All cell tanks were cleansed of operational debris, grease from agitators, etc. by personnel physically entering each tank. The tanks were assembled with new gaskets but were not modified except for minor process piping changes as listed in Item 9 below.

3. All cell tank agitators were overhauled with worn and defective parts being replaced. Some of the badly contaminated structural supports caused by process activity escaping from the unsealed agitator shaft were also replaced. After assembling and testing the agitators, the open stands were encased with "cocoon" to seal the agitator openings.

4. A large amount of contaminated concrete from the roof sampling area and Cell 3 floor was removed and replaced. All new concrete was painted with Amercoat, and the concrete in the sample area was covered with tarpaper and tar.

5. All columns were disassembled, cleansed, pressure tested, repacked and reassembled.

6. The Second Cycle Product Evaporator equipment was installed, complete with instrumentation, in Cell 3.

7. All service equipment such as instrument air compressor, Lectrodryer, Milton-Roy feed pumps, instrumentation, solvent recovery equipment, etc. was overhauled.

8. All cell and gallery tanks were recalibrated and more accurate calibration charts prepared.

9. A number of minor equipment modifications for operational and material accountability reasons were made as follows:

[redacted]

Appendix (Continued)

A. Replaced all contaminated small gaskets with teflon or teflon jacketed corrugated stainless steel core, "Chemseal" gaskets.

B. Repaired or replaced all cell ionization chambers.

C. Installed additional ring balance instrument to provide a recorded liquid level and specific gravity measurement for the Dissolver and both Feed Makeup Tanks.

D. Painted all concrete floors and structural steel in the cells.

E. Plugged all cell floor drains and column drip pans.

F. Provided "cocoon" around all ungasketed tank top flanges.

G. Removed the Dissolver to First Cycle Neutralizer (A1 to A8) jet and installed an additional thermocouple in the Dissolver.

H. Removed the Cell I Overflow Sump Tank eliminating the overflow lines from the First Cycle Feed Adjustment Tank, Neutralizer, and MCH Overflow Tank, (A4, A8 and A9).

I. Sealed the Cell I to Pile Canal opening with a poured concrete plug.

J. Provided backwash facilities on the roof for the Filter Tank filtering element (A11).

K. Re-routed the Filter Wash Catch Tank (A13) overflow from the Cell I Overflow Sump Tank to the First Cycle Neutralizer (A20 to A8), and provided specific gravity instrumentation and more adequate sampling facilities for A13.

L. Altered both the First and the Second Cycle Extraction Column scrub lengths from the approximately 15 feet used during Redox investigations to 7 and 7 1/2 feet respectively.

M. Re-routed all sampler and manual valve drip pan, drain lines for the first cell equipment from the Overflow Sump Tank (A20) to the First Cycle Neutralizer (A8).

N. Re-routed the overflow lines from miscellaneous extraction column accessories for each cycle from the respective neutralizer to the respective feed makeup tank (B1, 12 & 14 from A8 to A4, and B3 and 34 from B30 to B5).

O. Re-routed one of the waste jets from each of the neutralizers to the respective cycle feed makeup tank, (A8 to A4 and B30 to B5).

P. Provided samplers for both the First and Second Cycle Neutralizers (A8 and B30).

Q. Re-routed the condensate line from the Second Cycle Feed Adjustment Tank (B10 condensate) from the Neutralizer (B30) to the tank formerly used for catching the second cycle product (B8).

R. Eliminated the Second Cycle Stripping Column Aqueous Exit Sample Pot (B42) overflow line.

S. Increased the size of the Cell 2 Overflow Sump Tank (B20) and provided it with liquid level instrumentation and a return jet to the Second Cycle Waste Neutralizer Tank (B30).

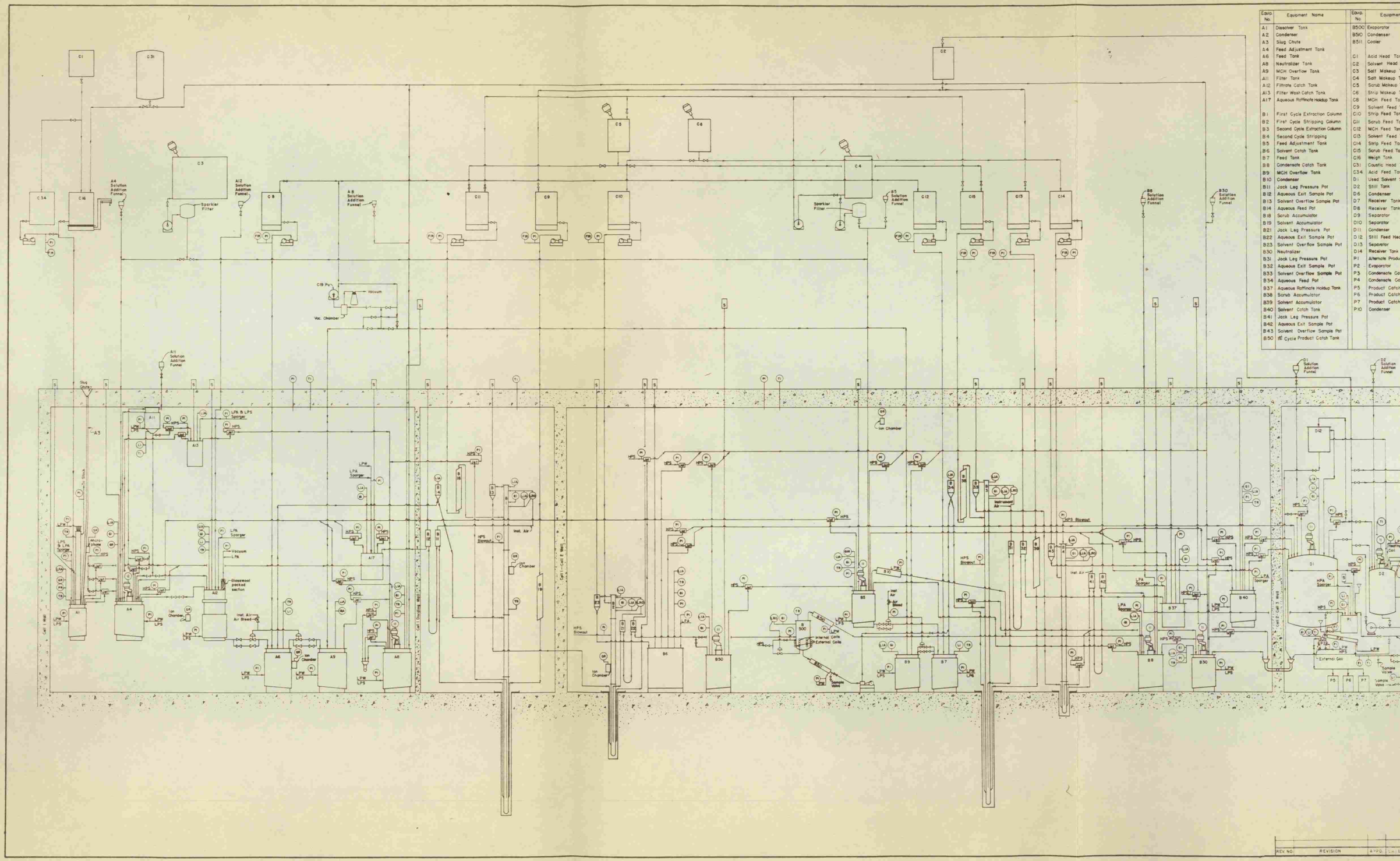
T. Pneumatically operated Hammel-Dahl valves and manual valves inspected and repaired.

U. Replaced the Cell 3 hexone pump (D1Pu) that had a conventional packed gland with one having a "Duraseal".

V. Provided controlled acid addition equipment for the Dissolver (A1) by the use of a spare pump (C34).

W. Provided valve locks to control movement of material from key vessels.

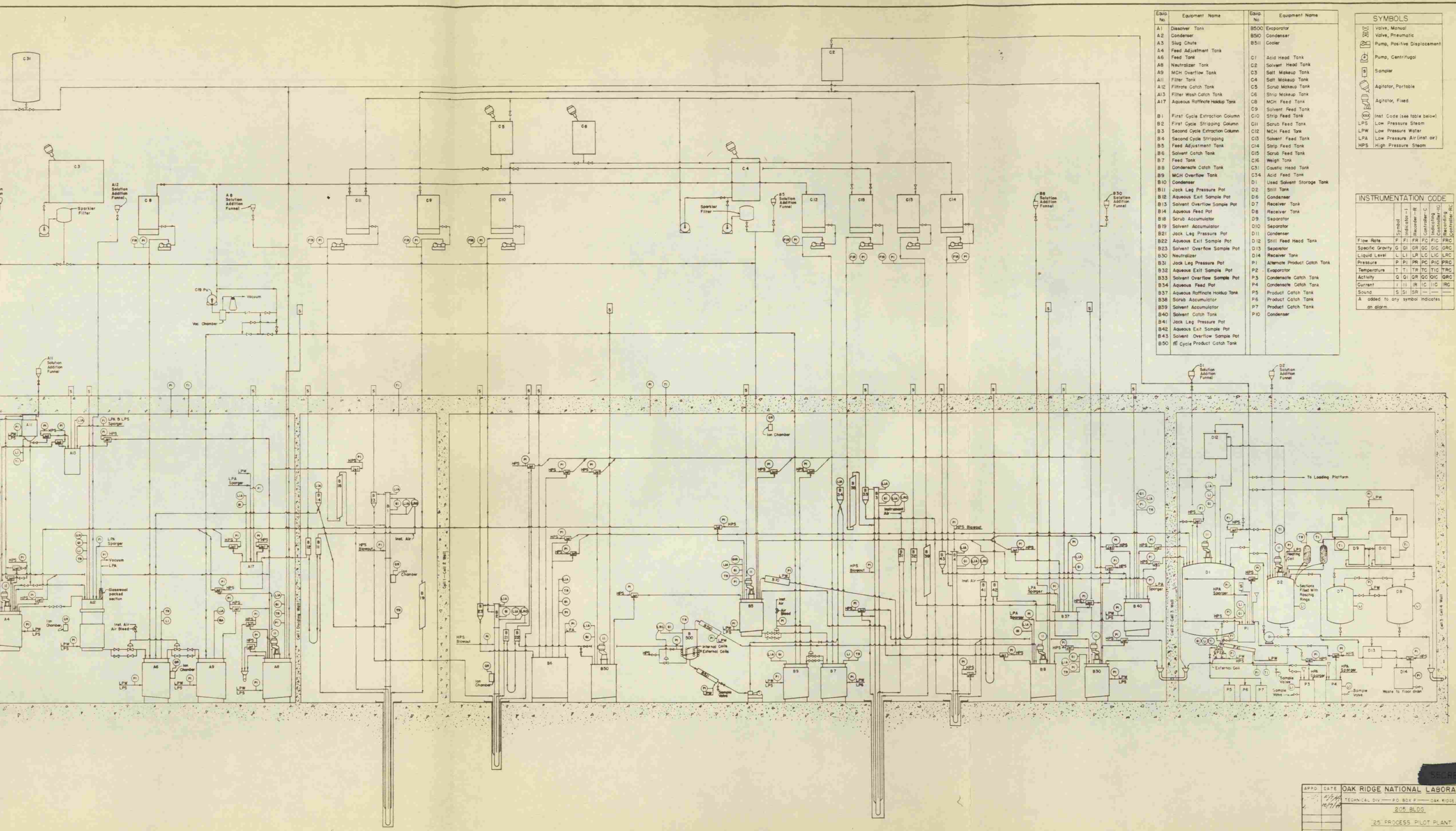
X. Blanked off all seldom used lines such as column jets, steam blowdowns, cell sprays, etc.



Equip. No.	Equipment Name
A1	Dissolver Tank
A2	Condenser
A3	Slug Chute
A4	Feed Adjustment Tank
A6	Feed Tank
A8	Neutralizer Tank
A9	MCH Overflow Tank
A11	Filter Tank
A12	Filtrate Catch Tank
A13	Filter Wash Catch Tank
A17	Aqueous Raffinate Holdup Tank
B1	First Cycle Extraction Column
B2	First Cycle Stripping Column
B3	Second Cycle Extraction Column
B4	Second Cycle Stripping
B5	Feed Adjustment Tank
B6	Solvent Catch Tank
B7	Feed Tank
B8	Condensate Catch Tank
B9	MCH Overflow Tank
B10	Condenser
B11	Jack Leg Pressure Pot
B12	Aqueous Exit Sample Pot
B13	Solvent Overflow Sample Pot
B14	Aqueous Feed Pot
B18	Scrub Accumulator
B19	Solvent Accumulator
B21	Jack Leg Pressure Pot
B22	Aqueous Exit Sample Pot
B23	Solvent Overflow Sample Pot
B30	Neutralizer
B31	Jack Leg Pressure Pot
B32	Aqueous Exit Sample Pot
B33	Solvent Overflow Sample Pot
B34	Aqueous Feed Pot
B37	Aqueous Raffinate Holdup Tank
B38	Scrub Accumulator
B39	Solvent Accumulator
B40	Solvent Catch Tank
B41	Jack Leg Pressure Pot
B42	Aqueous Exit Sample Pot
B43	Solvent Overflow Sample Pot
B50	1st Cycle Product Catch Tank

Equip. No.	Equipment N
B500	Evaporator
B510	Condenser
B511	Cooler
C1	Acid Head Tank
C2	Solvent Head Tan
C3	Salt Makeup Tan
C4	Salt Makeup Tan
C5	Scrub Makeup Tan
C6	Strip Makeup Tan
C8	MCH Feed Tank
C9	Solvent Feed Tan
C10	Strip Feed Tank
C11	Scrub Feed Tank
C12	MCH Feed Tank
C13	Solvent Feed Tan
C14	Strip Feed Tank
C15	Scrub Feed Tank
C16	Weigh Tank
C31	Caustic Head Tan
C34	Acid Feed Tank
D1	Used Solvent Sto
D2	Still Tank
D6	Condenser
D7	Receiver Tank
D8	Receiver Tank
D9	Separator
D10	Separator
D11	Condenser
D12	Still Feed Head
D13	Separator
D14	Receiver Tank
P1	Alternate Product
P2	Evaporator
P3	Condensate Catch
P4	Condensate Catch
P5	Product Catch T
P6	Product Catch T
P7	Product Catch T
P10	Condenser

REV. NO.	REVISION	APPD.	DATE



Equip. No.	Equipment Name	Equip. No.	Equipment Name
A1	Dissolver Tank	B500	Evaporator
A2	Condenser	B510	Condenser
A3	Slug Chute	B511	Cooler
A4	Feed Adjustment Tank		
A6	Feed Tank	C1	Acid Head Tank
A8	Neutralizer Tank	C2	Solvent Head Tank
A9	MCH Overflow Tank	C3	Salt Makeup Tank
A11	Filter Tank	C4	Salt Makeup Tank
A12	Filtrate Catch Tank	C5	Scrub Makeup Tank
A13	Filter Wash Catch Tank	C6	Strip Makeup Tank
A17	Aqueous Raffinate Holdup Tank	C8	MCH Feed Tank
		C9	Solvent Feed Tank
B1	First Cycle Extraction Column	C10	Strip Feed Tank
B2	First Cycle Stripping Column	C11	Scrub Feed Tank
B3	Second Cycle Extraction Column	C12	MCH Feed Tank
B4	Second Cycle Stripping	C13	Solvent Feed Tank
B5	Feed Adjustment Tank	C14	Strip Feed Tank
B6	Solvent Catch Tank	C15	Scrub Feed Tank
B7	Feed Tank	C16	Weigh Tank
B8	Condensate Catch Tank	C31	Caustic Head Tank
B9	MCH Overflow Tank	C34	Acid Feed Tank
B10	Condenser	D1	Used Solvent Storage Tank
B11	Jack Leg Pressure Pot	D2	Still Tank
B12	Aqueous Exit Sample Pot	D6	Condenser
B13	Solvent Overflow Sample Pot	D7	Receiver Tank
B14	Aqueous Feed Pot	D8	Receiver Tank
B18	Scrub Accumulator	D9	Separator
B19	Solvent Accumulator	D10	Separator
B21	Jack Leg Pressure Pot	D11	Condenser
B22	Aqueous Exit Sample Pot	D12	Still Feed Head Tank
B23	Solvent Overflow Sample Pot	D13	Separator
B30	Neutralizer	D14	Receiver Tank
B31	Jack Leg Pressure Pot	P1	Alternate Product Catch Tank
B32	Aqueous Exit Sample Pot	P2	Evaporator
B33	Solvent Overflow Sample Pot	P3	Condensate Catch Tank
B34	Aqueous Feed Pot	P4	Condensate Catch Tank
B37	Aqueous Raffinate Holdup Tank	P5	Product Catch Tank
B38	Scrub Accumulator	P6	Product Catch Tank
B39	Solvent Accumulator	P7	Product Catch Tank
B40	Solvent Catch Tank	P10	Condenser
B41	Jack Leg Pressure Pot		
B42	Aqueous Exit Sample Pot		
B43	Solvent Overflow Sample Pot		
B50	1st Cycle Product Catch Tank		

SYMBOLS

- Valve, Manual
- Valve, Pneumatic
- Pump, Positive Displacement
- Pump, Centrifugal
- Sampler
- Agitator, Portable
- Agitator, Fixed
- (Inst Code (see table below))
- LPS Low Pressure Steam
- LPW Low Pressure Water
- LPA Low Pressure Air (inst air)
- HPS High Pressure Steam

INSTRUMENTATION CODE

	Symbol	Indicator - I	Recorder - R	Controller - C	Indicating Controller - IC	Recording Controller - RC
Flow Rate	F	FI	FR	FC	FIC	FRC
Specific Gravity	G	GI	GR	GC	GIC	GRC
Liquid Level	L	LI	LR	LC	LIC	LRC
Pressure	P	PI	PR	PC	PIC	PRC
Temperature	T	TI	TR	TC	TIC	TRC
Activity	Q	QI	QR	QC	QIC	QRC
Current	I	II	IR	IC	IIC	IRC
Sound	S	SI	SR	—	—	—
A added to any symbol indicates an alarm.						

[redacted]

APPD	DATE	OAK RIDGE NATIONAL LABORATORY
	4/7/49	TECHNICAL DIV — P.O. BOX P — OAK RIDGE, TENN.
	12/7/48	205 BLDG.
		25 PROCESS PILOT PLANT
		EQUIPMENT & INSTRUMENT FLOWSHEET
		PAGE 21
		DRAWN BY: DATE 6-7-49 SCALE None
		DATE — 49 DRAWING NO. D-49-7813 REV.

REV. NO.	REVISION	APPD.	DATE