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EUROCHEMIC ASSISTANCE PROGRAM PROGRESS REPORT FOR JULY-DECEMBER 1962

by

E. M. Shank

ABSTRACT

The Eurochemic staff has been expanded to about 195 people; this expansion will continue until the authorized complement of 450 people are reached. The pre-project designs have been completed for all facilities. The plant capacity remains as previously reported except for the plutonium facility, which has been reduced from 3.0 to 1.5 kg/day. A revised cost estimate made in September 1962 gives a construction cost of 24.67 million dollars with an additional 6.03 million dollars operating cost through 1963. The civil engineering design is about 80% complete and construction is about 50% complete; building construction is about six months behind the schedule anticipated in November 1961.

The main process consists of two solvent extraction cycles of a Purex type flowsheet. The plutonium facility is being designed to use a 30% TBP flowsheet. A new French stainless steel, Uranus S, is being evaluated as a material for waste evaporators. Two special studies were made relative to the processing of enriched uranium on the Eurochemic site; a final decision from the Board is expected by July 1963. The Board has authorized the management to start preliminary processing contract negotiations.

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Laboratory-scale physical chemistry studies have been made on iodine release into the off-gas system and on the conditioning of UO_2 and PuO_2 . Similar scale process chemistry studies have included zirconium dissolution by citrate-buffered HF, Zirflex and magnesium dissolution, U-Al solution clarification, enriched uranium processing, and plutonium extraction by 20% TLA-Solvesso 100 followed by oxalic acid precipitation from the organic phase. Pilot plant scale studies have continued on pulsed column operation, diluent washing, air pulsation, sampling, evaporation, metering jets, slurry detection, and dissolution.

The third US technical advisor, E. M. Shank of ORNL, arrived in July 1962.

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1.0 INTRODUCTION

The United States Atomic Energy Commission has entered into a program of assistance to the European Company for the General Processing of Irradiated Fuels (EUROCHEMIC). The program started in September 1958 and has consisted of one resident technical advisor, short-term visits of technical consultants from various USAEC sites, technical co-ordination by ORNL, and the review and exchange of technical data pertinent to the radiochemical processing of irradiated fuels. This report covers the progress during the period July 1962 through December 1962 and gives the status of the program as of January 1, 1963. Other reports in this series are listed in Sect. 6.1.

2.0 EUROCHEMIC ORGANIZATION

Eurochemic has been constituted under the auspices of ENEA (1) as a OEEC (2) - joint undertaking by 13 countries. Its legal form is a share-holding company with governments, governmental organizations, and private industry as shareholders. Supervision of the company by the Signatory Governments is exercised through the Special Group of the Steering Committee of ENEA. The senior body of the company is a General Assembly which consists of all shareholders. Other OECD joint undertakings are the Dragon and Halden reactor projects.

The basic organization of Eurochemic remains as shown in the status report for July 1960 through June 1961 (ORNL-CF-61-8-68). A general increase in personnel has occurred and will continue until the total authorized staff of 450 people are reached. The staff is expected to reach 331 by the end of 1963. The present staff (Fig. 1) numbers 195, which is distributed as follows:

Central Headquarters	7
Administration Department	41
Technical Department	63
Research Department	84

Central headquarters is located in Brussels and contains the General Manager and his staff. The remaining three departments are located in Mol. The principal sections for the Technical and Research Departments are shown in Sect. 6.2.

-
- (1) European Nuclear Energy Agency, a Branch of OECD.
 - (2) Organization for European Economic Cooperation, Transformed Beginning 1962 into Organization for European Cooperation and Development (addition of US + Canada).

G E N E R A L A S S E M B L Y

BOARD OF DIRECTORS

Technical Committee

Director General's Office - E. Pohland (7)

Secretariat General

Administrative Department: M.Y. Leclercq-Aubretton (41)

Personnel Office and General Mail

General Services, Purchasing, Contracts

Finance Office

Technical Department: T. J. Barendregt (63)

US Technical Advisor

Analytical Laboratory

Plant Process

Transportation, Storage, Waste

General Services

Instrumentation Development

Research Department: R. Rometsch (84)

Technical Secretariat

Documentation

Health and Safety

Applied Chemistry

Testing Station

Analytical Chemistry

Physical Chemistry

Fig. 1. Eurochemic Organization (December 31, 1962).

3.0 PROJECT ENGINEERING - TECHNICAL DEPARTMENT

The pre-project (scope) designs for all facilities have been completed including the plutonium purification (completed December 15, 1962) and the enriched uranium annex. The plutonium purification pre-project will be submitted to the Board of Directors in March 1963. Selection of the process architect-engineer will proceed immediately following Board approval. This selection is expected by April 1963.

3.1 Plant Capacity and Cost Estimate

The main plant process capacity remains as previously reported, namely:

- a) Aluminum- and magnesium-clad fuels: 350 kg U/day
- b) Stainless steel- and Zircaloy-clad fuels: 200 kg U/day
- c) Maximum enrichment: 5% U-235
- d) Maximum irradiation: 10,000 Mwd/ton, 15 Mw/ton
- e) Types of cladding: Al, Mg, Magnox, Zr, Zircaloy, or SS
- f) Types of cores: U metal, UO₂, U-10% Mo alloy

The plutonium tail-end system is being designed with a capacity of 1.5 kg Pu/day. This capacity will permit processing the anticipated load in 100 days, leaving an additional 100 days for other types of plutonium-bearing fuels (such as fast breeder fuels). The capacity for fuel enriched to 20% and 90% U-235 remains at 28 and 9.7 kg U/day, respectively; however, approval has not been given to proceed with detailed design of the enriched uranium annex.

The architect engineers for the main plant prepared a new cost estimate, as of June 1963, for their respective area. These estimates have been revised by Eurochemic as of September 1962. A minor reduction is indicated when compared with the pre-project estimate of January 1961. However, inclusion of the investment for laboratory equipment and other minor revisions results in the total cost remaining at the January 1961 figures. Also, construction costs for the Research Laboratory have increased to the extent that only one hot cell can be equipped with the present funds. The present cost estimate, compared to the estimate made in January 1961, is given in Table 1.

3.2 Civil Engineering

The responsible architect engineers and/or contractors, the status, and the anticipated completion date are shown (Table 2) for the main buildings. The estimated completion for the civil engineering construction is about six months behind schedule. This delay has resulted from the following factors:

- a) Installation of a 200 m³ emergency storage basin, which was not initially foreseen (loss of 2 months).
- b) Unfavorable weather (loss of 2.5 months).
- c) Poor planning by the contractors (loss of 1.5 month).

	<u>Estimate X10⁶ \$</u>			
	<u>Jan. 1961</u>	<u>Sept. 1962</u>		
Site and Site Development	0.46	0.66		
General Services & Utilities	2.63	1.65		
Office Building	0.16	0.19		
Main Plant				
Civil Engineering	3.489	3.088		
Make-up, Inactive Storage	.315	.369		
Reception and Storage	.620	.579		
Water Treatment	.200	.167		
Head-End	.746	1.025		
Extraction and U Handling	.625	.770		
Acid and Solvent Recovery	.545	.991		
Waste Handling & Rework	.712	1.155		
Ventilation & Process Off-gas	.903	1.621		
Services & Electricity	1.114	1.177		
Sampling & Analytical Lab.	.600	.697		
Control	1.542	1.480		
Contingencies	3.591	15.00	1.312	14.43
Research Laboratory	1.32	1.32	1.32	
Waste Treatment & Storage	1.07	1.07	1.07	
Final Plutonium Purification	.37	.37	.37	
Second Dissolver	.80	.80	.80	
Pilot Dissolver	.30	.30	.25	
Engineering	1.80	1.80	1.80	
Enriched U Modification	-	-	.15	
Laboratory Equipment	0.66	0.66	1.78	
Miscellaneous Investment	.10	.10	.20	
Subtotal	<u>24.67</u>	<u>24.67</u>	<u>24.67</u>	
Eurochemic Expense				
1958-1962	4.03	4.03	4.03	
1963	2.00	2.00	2.00	
TOTAL	<u>30.70</u>	<u>30.70</u>	<u>30.70</u>	

Table 1. Eurochemic Cost Estimates - January 1961 and September 1962.

FACILITY	No.	A. E.	DESIGN		CONSTRUCTION			
			Complete		Contractor (1)	Complete (2)		
			%	Est. Date		%	11/6 Sch.	Est. Date
Main Plant	1	S.G.N.	80	3/63	Group	35	1/63 8/63	8/63 6/64
Lining			80	3/63				12/63
Reception & Storage	2	NOHAB	95	3/63	Group	80	8/62 1/63	6/63 9/63
Lining			100	-		30	6/62	3/63
Analytical Lab	3	IGK	75	4/63	Group	40	1/63 7/63	4/63 2/64
Fan & Filter House	4	S.G.N.	0	2/63	Group	0	1/63 4/63	7/63 9/63
Stack	20	S.G.N.	20	3/63	?	0	-	9/63
High Level Waste	5	NORATOM	95	5/63	Group	25	1/63 3/63	5/63 7/63
U & Pu Product Storage	6	Montecatini	80	5/63	Group	5	1/63 7/63	6/63 9/63
Tank Farm	7	Eurochemic	100	-	Belmans	85	-	3/63
Liquid Effluent (STE)	8	Belchim	65	3/63	Group	25	1/63 4/63	6/63 10/63
General Services	9	Eurochemic	100	-	Belmans	100		8/62 11/62
Research Lab	10	S.D.S.	100	-	Group	85	8/62 4/63	2/63 6/63
Utilities		Eurochemic	100	-	Belmans			
Water Treat.	12					95	-	2/63
Elec. Sub. Sta.	13					100	-	3/62
Chem. Storage	14					10	-	9/63
Site & Facilities		Eurochemic	60	-	?	0	-	12/63
Canteen	15		5	4/63	?	0	-	8/63
Guard House	16		5	4/63	?	60	-	7/63

(1) Group is composed of two French and two Belgian firms.

(2) When two dates are given, first date is for rough construction and second date is for all finish work etc. When only one figure is given, the date is for all finish work.

Table 2. Eurochemic Civil Engineering Status of Design and Construction.

3.3 Process Engineering

The main line process remains essentially as outlined in the pre-project (No. 4) and is patterned after the Purex process. The head-end system (Fig. 2) includes dejacketing and dissolution in a single vessel, clarification by centrifugation, and intermediate storage in cylindrical slab-type tanks. The first solvent extraction cycle (Fig. 3) provides for co-decontamination and partitioning of the uranium and plutonium. Further decontamination of the uranium is provided by a second solvent extraction cycle (Fig. 4). Additional decontamination of the uranium product may be obtained by passage through a silica gel column. The final form of the uranium product will be as a 2 M UNH solution.

The final plutonium cycle will use a 30% TBP flowsheet followed by oxalic acid precipitation and calcination at 450°C (Fig. 5). The 10% TLA flowsheet (reported in ORNL-TM-246 and described in ETR-135) has been rejected owing to processing difficulties. A new flowsheet (see Sect. 4.1) using 20% TLA-Solvesso 100 has given such encouraging laboratory-scale results that the project design will permit either chemical flowsheet (30% TBP or 20% TLA) to be used.

3.4 Materials of Construction

The French Atomic Energy Installation at Saclay has conducted a series of corrosion tests on proposed materials of construction for the 1 WW evaporator. The CEA studied several French stainless steels to evaluate the effects of F⁻ and Cr⁺⁶ ions.

Since type 304 L stainless steel is being considered by Eurochemic, comparative tests between it and the French stainless steels were made. The composition of the French stainless steels studied are given below:

Material	<u>Composition in % of Total</u>							
	Cr	Ni	C	Mo	Si	Cu	Mn	Others
Uranus B 6	20	25	0.017	1.21	0.73	1.68	5.30	~ 46.1
Uranus 65 (Nb stabl.)	25	20	?	?	?	?	?	?
Uranus S	17	14	0.02	-	4.0	-	-	~ 65.0
Uranus SD	17	14	0.02	2.3	4.0	-	-	~ 62.7

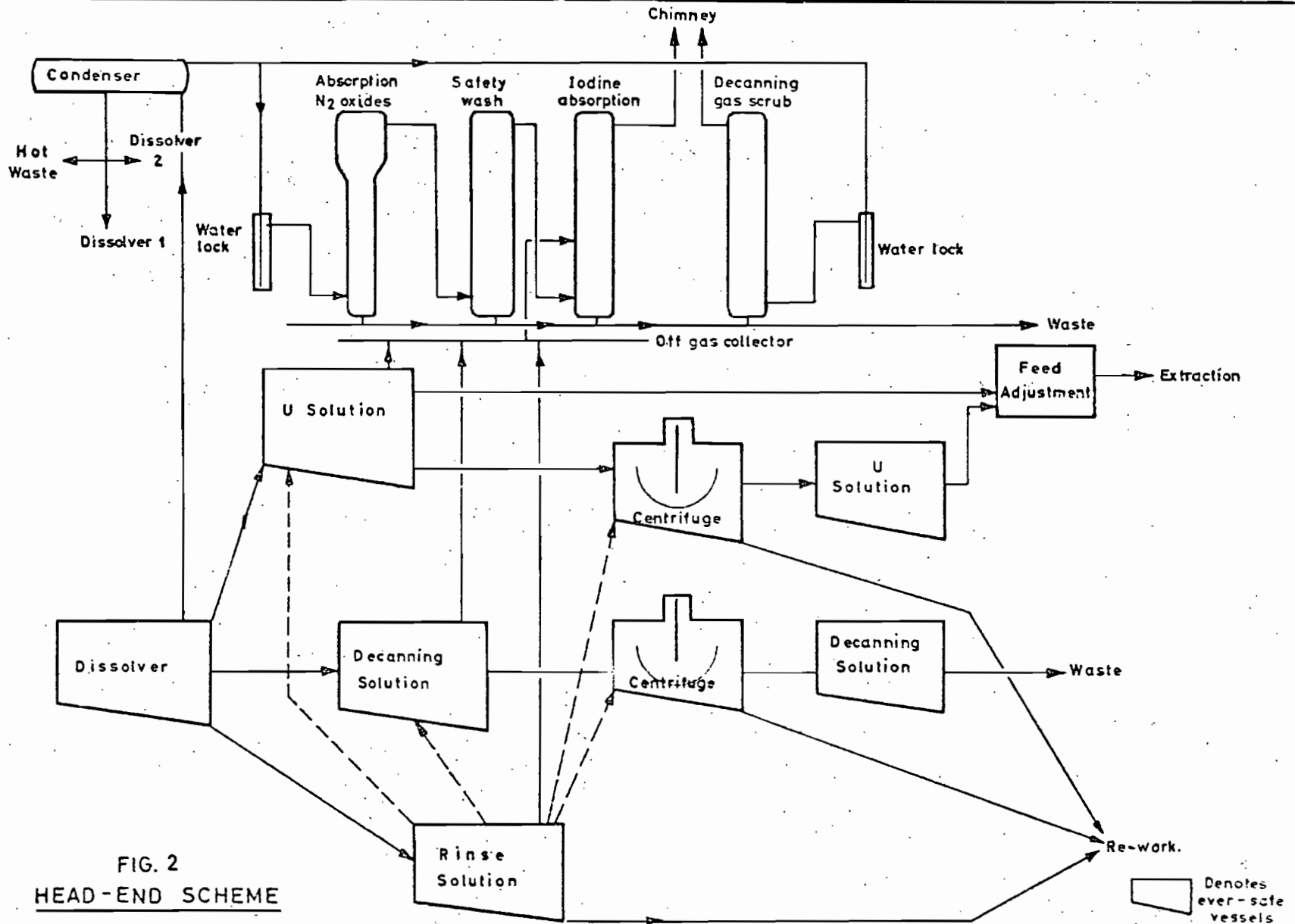


FIG. 2
HEAD-END SCHEME

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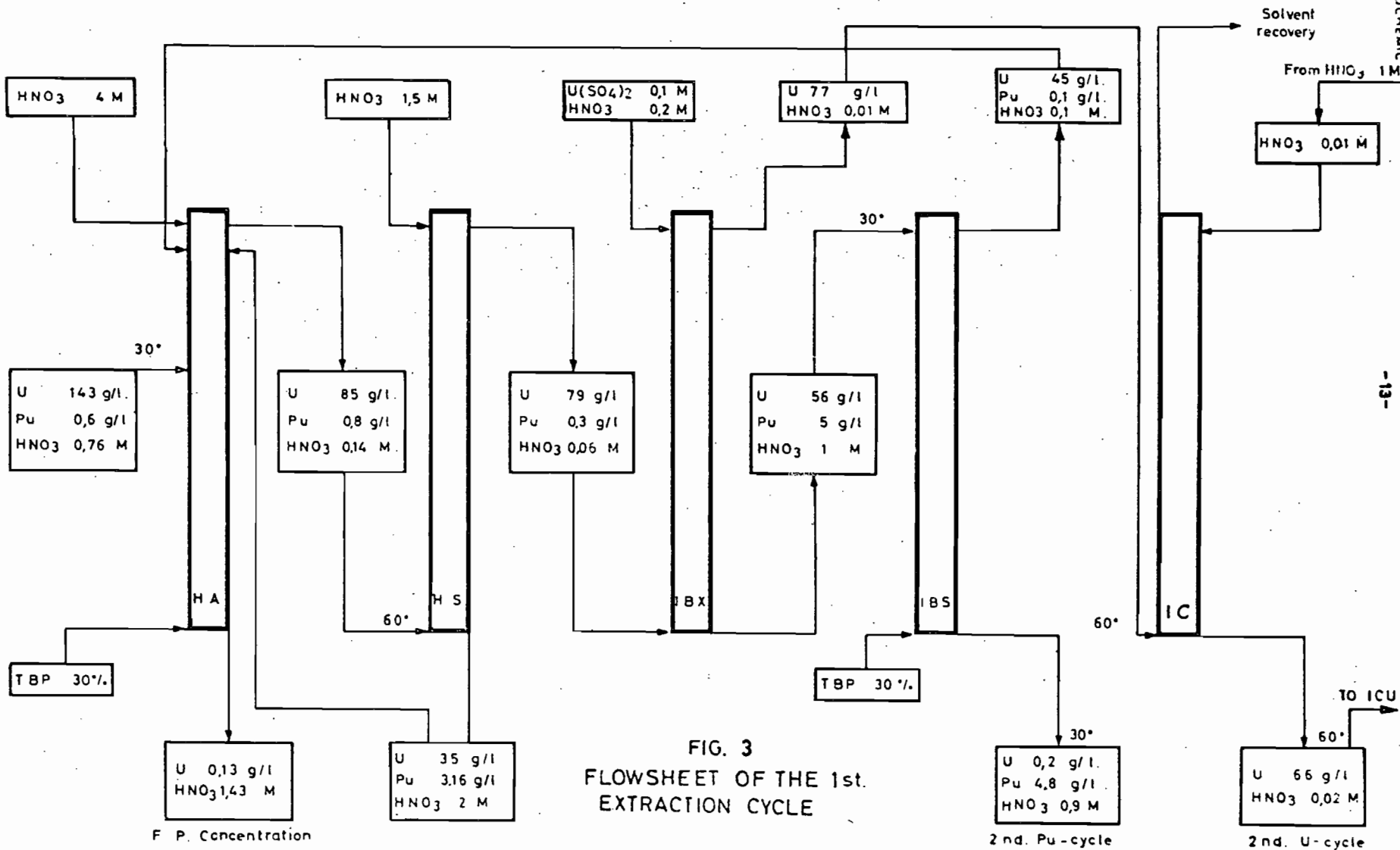


FIG. 3
FLOWSHEET OF THE 1st.
EXTRACTION CYCLE

FURCHEMATIC

64104-52

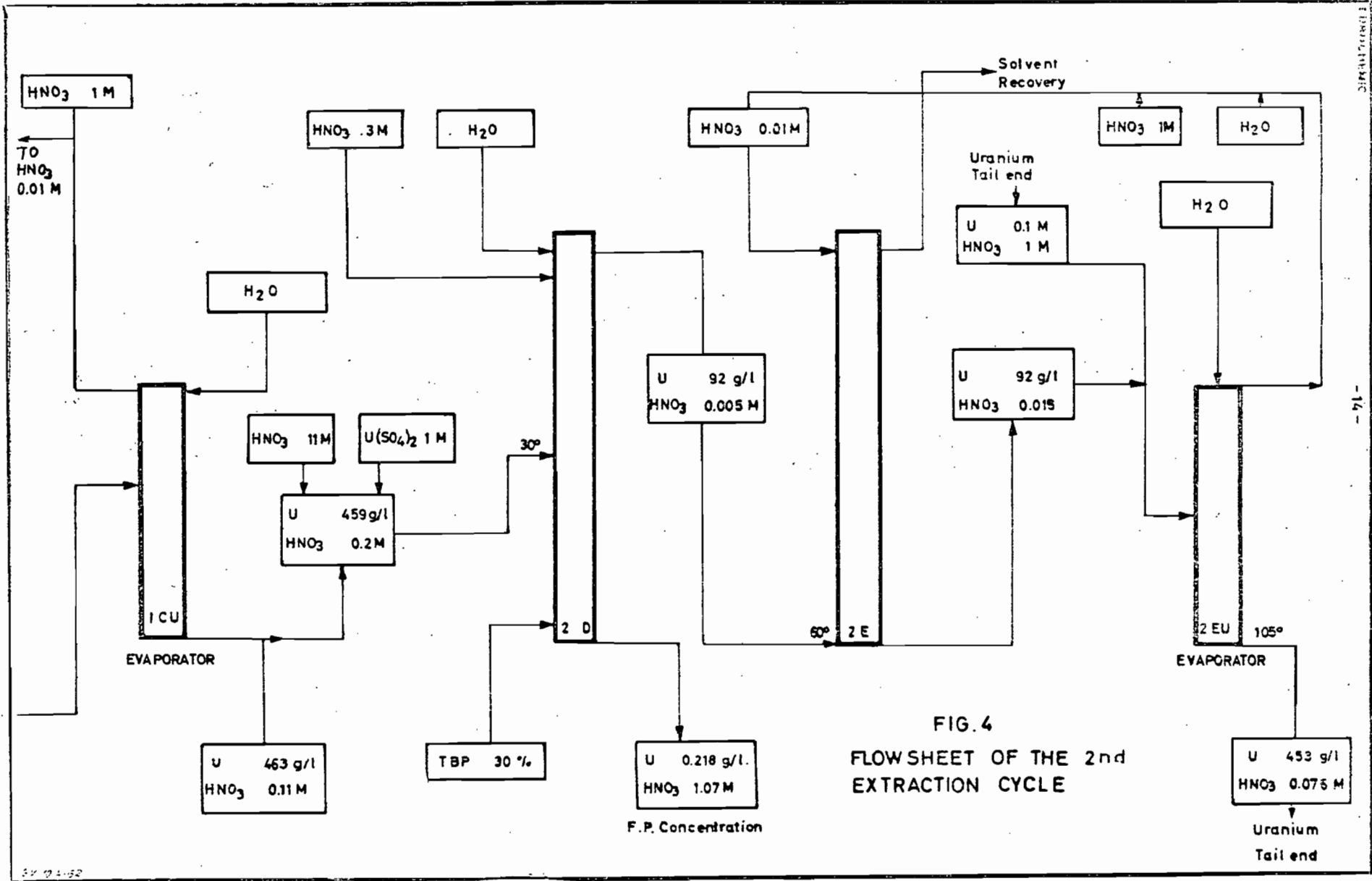


FIG. 4
 FLOWSHEET OF THE 2nd
 EXTRACTION CYCLE

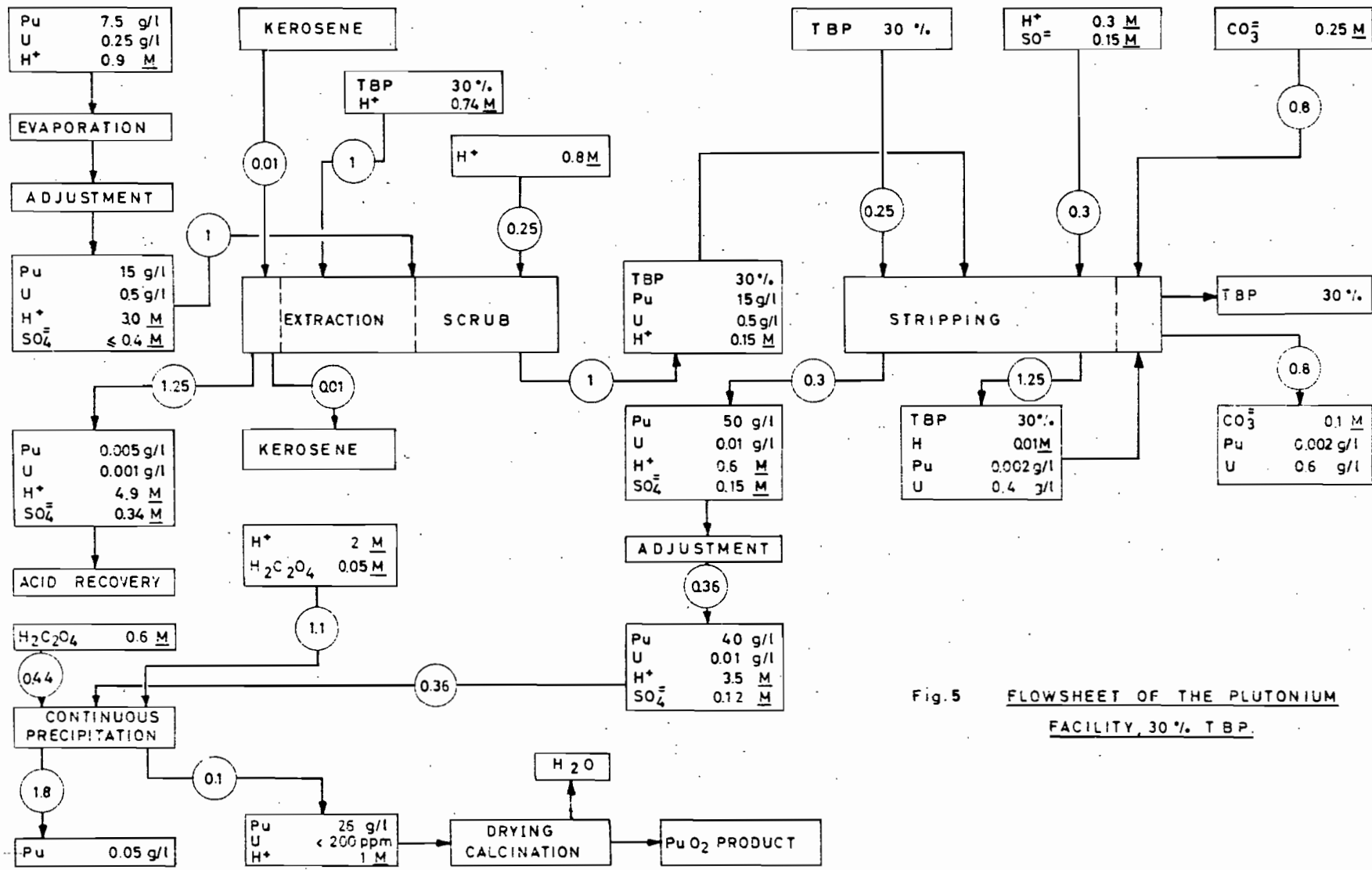


Fig. 5 FLOWSHEET OF THE PLUTONIUM FACILITY, 30% TBP.

Four basic solutions were used in the corrosion tests, as follows:

Solution A: HNO₃ varied from 3 M to 11 M, 1 g/l Cr⁺⁶, temperature at BP, solution changed every 24 hrs, tests conducted for several weeks.

Solution B: 7 M HNO₃, 0.5 M Al F₃, temperature at BP, tests conducted for several weeks.

Solution C: 7 M HNO₃, 1 g/l Cr⁺⁶, 0.5 M F⁻, 0.5 M Al (NO₃)₃, temperature at BP, solution changed every 24 hours, tests conducted for 3 days.

Solution D: Same as solution C but without Cr⁺⁶.

Preliminary results may be summarized as follows:

1. The addition of Si decreases the effects of stress corrosion by Cl⁻ and intergranular corrosion by Cr⁺⁶.
2. Uranus S, in solution A, showed a uniform corrosion rate of 4 to 20 mils/yr as the nitric acid concentration varied from 3 M to 11 M.
3. Uranus SD, in solution A, showed a similar rate as Uranus S at 3 M HNO₃ but four times the rate at 11 M HNO₃.
4. Standard stainless steels (apparently similar to US type 347) showed rates 30 times greater than Uranus S under equivalent conditions.
5. Tests with solution B give the lowest rates for Uranus 65 with increasing rate factors of two for Uranus B 6, four for Uranus S, and eight for Uranus SD.
6. Uranus 65, Uranus S, and type 304 L stainless steels were tested in solution C. All three materials showed comparable corrosion rates with no evidence of intergranular attack.

A similar three-day test was made without changing the solution and at 96°C temperature. Under this condition, Uranus 65 and 304 L showed a rapidly accelerating corrosion rate (factor of 10) after the first day; this accelerated rate was not shown by Uranus S.

7. Tests with the materials of item 6 in solution D gave rates for Uranus S which were four times higher than Uranus 65 and about two times higher than 304 L.

Owing to the uncertainties associated with the tests (short test periods) and the fabrication of Uranus S (this material is new and has not been commercially utilized), Eurochemic has requested additional tests to be performed by the CEA. Simultaneously, bids for the evaporator are requesting quotations for both 304 L and Uranus S as alternative materials of construction.

3.5 Special Studies

Two studies have been made relative to the processing of enriched uranium at the Eurochemic site. The first study (EIR-86) was an evaluation of the operational aspects of enriched uranium processing as now proposed at Eurochemic. This study evaluated the effects of material holdup, equipment operability, scheduling requirements, and safety (criticality and accountability control). The conclusions from the study indicated that the proposed annex will provide the quickest and most economical short-range method available for processing enriched uranium in Europe.

The second study (EIR-88) was a comparison of investment and operating cost for nine alternatives for MTR- and breeder fuel processing at the Eurochemic site. This study was made in cooperation with the French CEA. The results of the study, substantiating the conclusions of the first study, showed that a reasonable economical saving could be realized by immediately constructing the proposed annex and later adding a head-end and solvent extraction facility for breeder type fuels.

3.6 Fuel Processing Contract Negotiations

The Board of Directors, at their October 1962 meeting, authorized Eurochemic to proceed with preliminary processing negotiations with reactor operators. To this end, a sample contract is being prepared. Following review, and revision if required, various European reactor operators will be contacted. The principal difficulties being encountered in preparing the sample contract are the determination of realistic shipping charges and probable processing charges in the US.

4.0 RESEARCH AND DEVELOPMENT - RESEARCH DEPARTMENT

4.1 Laboratory-Scale Studies

Laboratory-scale studies are being conducted for the head-end, the extraction system, and the final plutonium purification.

Head-End Studies

The Citriflex process is being developed as an alternative to the Zirflex process. In this process, citric acid is substituted for part of the sodium fluoride. Advantages of this process include reduction of the final fluoride content (from

about 0.6 M to about 0.2 M) and of the total salt content. A disadvantage is that the final waste volume is increased about 20% if the over-all dissolution rate is kept comparable to the Zirflex rate. Corrosion, chemical stability, and radiation stability appear satisfactory. The optimum initial concentration is 0.9 M NaF, 1.8 M citric acid, and 0.2 M NH_4NO_3 ; this gives dissolution rates of 2.3 and 1.4 $\text{mg}/\text{cm}^2/\text{min}$ for final concentrations of 0.4 M Zr and 0.5 M Zr, respectively.

The semi-pilot dissolver tests were interrupted, after about one year of operation, owing to a series of material failures. The dissolver is being repaired using stainless steel for the slab tank and the recirculating tube. During the operation, however, sulflex and magnesium decladding runs and UO_2 dissolution tests were completed; dissolution rates obtained agreed with rates obtained in the laboratory. Only two uranium metal dissolving runs were completed prior to the dissolver failure; preliminary results indicated a reduced dissolving rate as compared to laboratory data. Uranium dissolution studies will be continued with the new dissolver.

Studies are now being made on 1.5% and 10% Mo-uranium alloys. These studies will determine Mo solubility when dissolving U-1.5% Mo in HNO_3 , establish solubility curves of Mo as a function of HNO_3 and uranium concentrations, and evaluate possibilities of dissolving U-10% Mo by diluting the dissolver charge with unalloyed uranium. Preliminary conclusions show that U-1.5% Mo can be dissolved without Mo precipitation if the following final concentrations of U and HNO_3 are reached:

<u>Uranium, M</u>	<u>HNO_3, M</u>
0.7	2.2
0.8	2.8
0.9	3.2
1.0	3.8

Tests being made to permit drawing solubility curves for Mo versus uranium and HNO_3 concentration indicate some disagreement with published US and French data. Runs with mixed charges of U-10% Mo and U have shown that a part (7 to 30% of total) of the initially precipitated Mo can be redissolved by dilution and digestion at the boiling temperature.

Tests on NH_3 removal by steam distillation or direct distillation have confirmed published data that steam distillation is more efficient.

Extraction Studies

The enriched uranium flowsheet (3) tests have been terminated pending a final decision by the Board of Directors on enriched uranium processing at Eurochemic. These tests, using feed containing a specific activity of about 10^3 less than expected, shows the following:

- the gross beta D.F. is higher than estimated
- ten actual scrub stages (mixer-settler) will give adequate gross gamma and beta decontamination
- the decontamination factors for the 6% TBP flowsheet (20% enriched U) is similar to that for the 3.25% TBP (90% enriched U)
- the plutonium separation is about four times greater with the 6% TBP flowsheet as with the 3.25% TBP flowsheet; this may be due to the difference in ages of the sulfamate scrub solution.

Cold run stripping tests with aged HAP solutions (3.25% and 6% TBP) indicates stripping difficulties with aging periods greater than 8 to 10 hours. This detrimental effect is thought to result from the hydrolysis by the ANN scrub since similar effects were not seen with the 30% TBP Purex flowsheet.

Parameter studies have been made for a dual scrub highly enriched uranium flowsheet. Factors considered are as follows:

- the selected ANN concentration of the high acid scrub (HSS₁) must not give excessive uranium reflux
- the second scrub (HSS₂) must decrease the acidity in the extraction column organic product (HSP) to about 0.01 M
- the A/O ratio must be low enough to keep a reasonable HAW volume

Based on these studies, a proposed flowsheet has been calculated and is given below:

(3) Internal Report, "Design Basis Flowsheet: Processing of Highly Enriched Uranium Fuels at Eurochemic."

	HA Unit						HS ₁ Unit, HS ₂ Unit					
	HAF		HAX		HAW		HSS ₁		HSS ₂		HSP	
	93%	20%	93%	20%	93%	20%	93%	20%	93%	20%	93%	20%
U g/l	2.36	6.0	-	-	0.0002	0.003	-	-	-	-	2.8	9.4
HNO ₃ , M	1.0	1.0	-	-	1.3	1.3	7.5	7.5	-	-	0.01	0.01
ANN, M	1.7	1.2	-	-	1.56	1.13	-	-	1.25	1.25	-	-
% TBP	-	-	3.25	6	-	-	-	-	-	-	-	-
Flow	172.5	172.5	144	110	202.5	202.5	12	12	18	18	144	110

The 93% proposed flowsheet only has been tested. With this flowsheet, the required uranium recovery is obtained and the acid content of the HSB is 0.01 M after four HSS₂ stages with neutral ANN. Tests with activity have not been made, but are scheduled.

A pre-project is being prepared for a complete solvent extraction facility in the new Research Laboratory. This facility will be capable of handling 10 to 15 liters of feed containing a maximum activity of 2 curies/liter. The facility will contain feed preparation (dissolving, feed adjustment, etc.) equipment for Al-clad fuels and five mixer-settler settlers.

Plutonium Purification

Selection of the final plutonium purification flowsheet has involved evaluation of four possibilities.

- a) 30% TBP extraction, re-extraction, and precipitation by H₂C₂O₄
- b) 10% TLA-Shell Sol T extraction and direct precipitation by H₂O₂
- c) 20% TLA-Solvesso 100 extraction, re-extraction by reductant, and precipitation of Pu⁺³ by H₂C₂O₄
- d) 20% TLA-Solvesso 100 extraction and direct precipitation by H₂C₂O₄

The plutonium facility pre-project, which has been completed, is based on flowsheet (a); the detailed project will be done, however, in such a way as to enable flowsheet (d) to be used. Flowsheets (b) and (c) have been discarded owing to the following reasons:

Flowsheet (b) has a very low capacity, gave inconsistent losses and decontamination factors, and produced a precipitate difficult to handle.

Flowsheet (c) is more complicated than (d) and gave no apparent advantages.

Flowsheet (d), while preliminary, has given sufficiently encouraging results that studies will be continued to define the variables.⁽⁴⁾

4.2 Testing Station

The testing station is engaged in non-radioactive intermediate-scale evaluation of process chemistry and equipment. During this period, operations

(4) Internal Report, "Purification Ultime Du Plutonium Par Extraction a La TLA Et Precipitation Directe Sur La Phase Organique."

have been made with pulsed columns, the diluent washer, air pulsation, sampling (plant prototype), an evaporator, jets, a slurry detector, and a pilot dissolver. These results are summarized below. In general, the detailed results will be published in topical reports.

4.2.1 Pulsed Column Operation

The HA and HS columns (see Fig. 6) are operated organic continuous. Extensive work has been done on bottom interface control and on the effects of variables on flooding and efficiency.

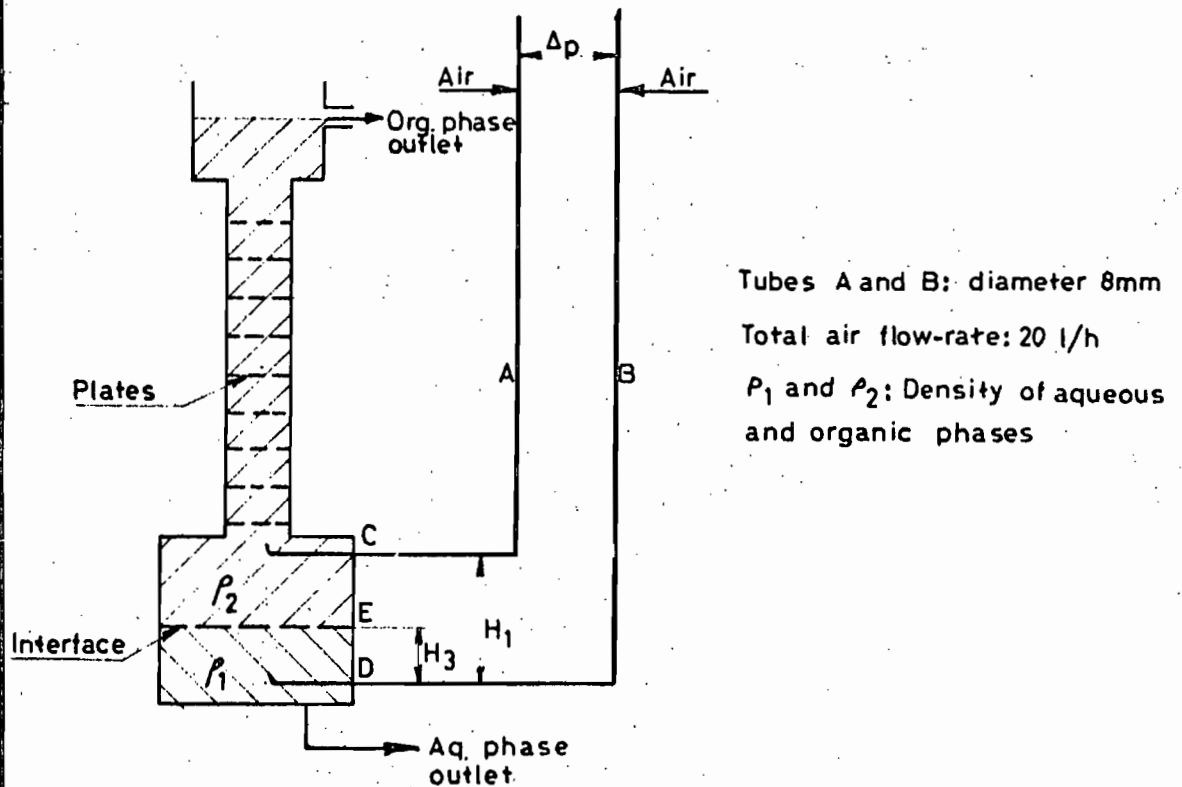
Bottom Interface Control

The test program on the 'liquid purged interface control' was finished, and effort was directed towards development and testing of the 'direct air purged' interface detection system. For this purpose, two air purge tubes of 8 mm I.D. (Fig. 6) were installed on the bottom decanter of the HA-HS unit (5), and the dp-cell was mounted above the liquid level. A membrane pulser was used to pulse the column.

Initial tests showed that interface control with this system was possible and that several advantages existed compared to the liquid purged method (e.g. shorter time-lag between interface movement and recorder signal and an increase in total throughput). Continued studying of the variables showed that the capacity increase was partly due to an amplitude loss in the column (Table 3), which remained greater than 15% higher than without air. No additional amplitude loss was found when repeating the same experiments in an air-pulsed unit; amplitude changes occurred only in the pulse tube.

A disadvantage of the direct air-purged system was, however, that calibration of the interface recorder was necessary as a function of amplitude and frequency (for constant air flow to the dip tubes). Differences in the differential pressure for the same interface position is due to the fact that the pulse losses in the dip tubes are influenced by the frequency and the amplitude. Reproducibility of the calibration seemed to be better with membrane pulsation than with air pulsation; detailed study on these effects continued.

(5) Internal Report, "Specifications Relatives à l'Équipement de l'Ensemble Pilote Extraction" (1958).



For Δp :

$$\text{Interface at pos (C) : } \Delta p = H_1 \cdot \rho_1 = H_1 (\rho_1 - \rho_2) + H_1 \cdot \rho_2$$

$$\text{" " " (E) : } \Delta p = H_3 \cdot \rho_1 + (H - H_3) \rho_2 = H_3 (\rho_1 - \rho_2) + H_1 \cdot \rho_2$$

$$\text{" " " (D) : } \Delta p = H_1 \cdot \rho_2 = H_1 \rho_2$$

In this case, the linear dependence between interface movement and change in Δp only occur when the density difference between the two phases and the absolute density of the light phase are constant.

D.3450

Fig.6 BOTTOM INTERFACE DETECTION WITH DIRECT AIR PURGE

Amplitude Without Air Introduction (mm)	Frequency (cpm)	Amplitude Loss for An Air Flow of 20 l/hr/dip Tube	Air Holdup in The Unit (HA-HS)
31	30 to 90	about 18%	1.5 to 2.5 vol %
22	30 to 90	about 22%	1.25 to 1.5 vol %
15	30 to 90	about 30%	0.8 to 1.3 vol %
8	30 to 90	about 40%	0.7 to 1.25 vol %

Flooding and Efficiency

Most of the work has been done using the 'Decontamination Cycle' (Fig. 7). A few tests have been made using the 'Second Uranium Cycle' of the Eurochemic flowsheet (7).

Decontamination Cycle. Pulsing the HA-HS unit with a membrane pulser gave flooding capacity increases of greater than 15% when using a direct air-purged interface system instead of the liquid-purged system (Fig. 8). This increase in capacity was shown in an air-pulsed bottom-interface-operated glass column. When having flooding conditions in the unit without air introduction, normal conditions were again obtained when air was introduced. The air introduced was effective in preventing premature coalescence and increasing the dispersion. The presence of large air bubbles was not seen.

Flooding capacities for the IC column (Fig. 9) increased significantly when the unit was pulsed with an air pulser instead of with a membrane pulser under the same amplitude and frequency conditions. Over-all average HETS values found were between 30 and 40 cm, which are about the previously obtained values.

Second Uranium Cycle. Initial flooding tests indicated a possible increased total throughput of about 50% compared with the capacities of the Decontamination Cycle. Further testing is continuing in order to determine the complete flooding curve.

(7) Internal Report, "Eurochemic Avant Project No. 4 (1960).

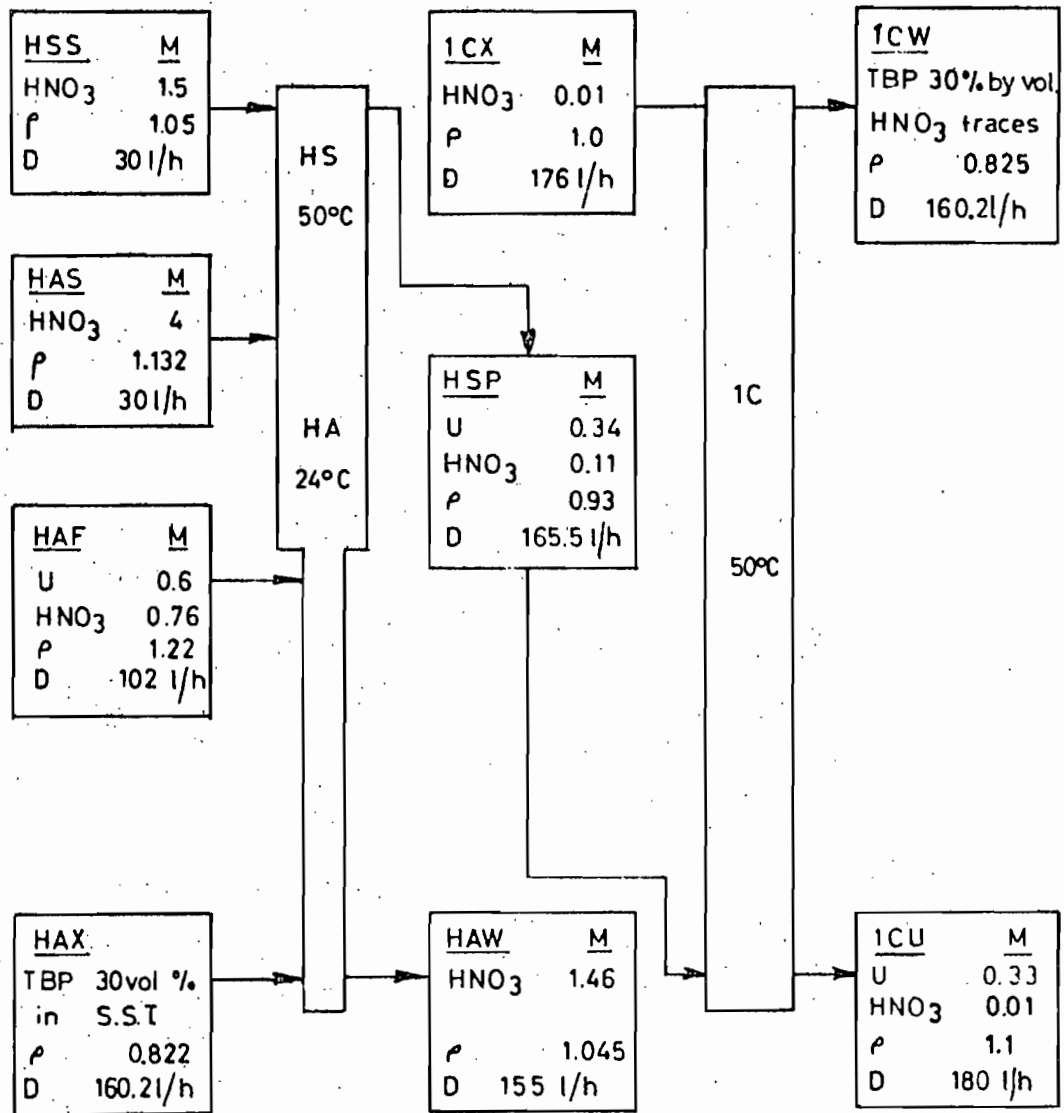


FIG. 7 DECONTAMINATION CYCLE FLOWSHEET OF PRE-PROJECT
 N° 4, AS CHECKED AT THE TESTING STATION

FIG. 8 FLOODING CAPACITY AS A FUNCTION OF THE AMPLITUDE-FREQUENCY PRODUCT FOR THE EXTRACTION PART OF THE HA-HS UNIT

Flowsheet: Decont. cycle
Plates: Type 2 C1
Interface: Bottom
Temperature: 24°C
Amplitude: 20 mm (checked)
Pulsation: Membrane
Organic/aqueous = 1

XXXXXX Liquid purged I.F. (30 l/h)
////// Air purged I.F. (20 l/h)

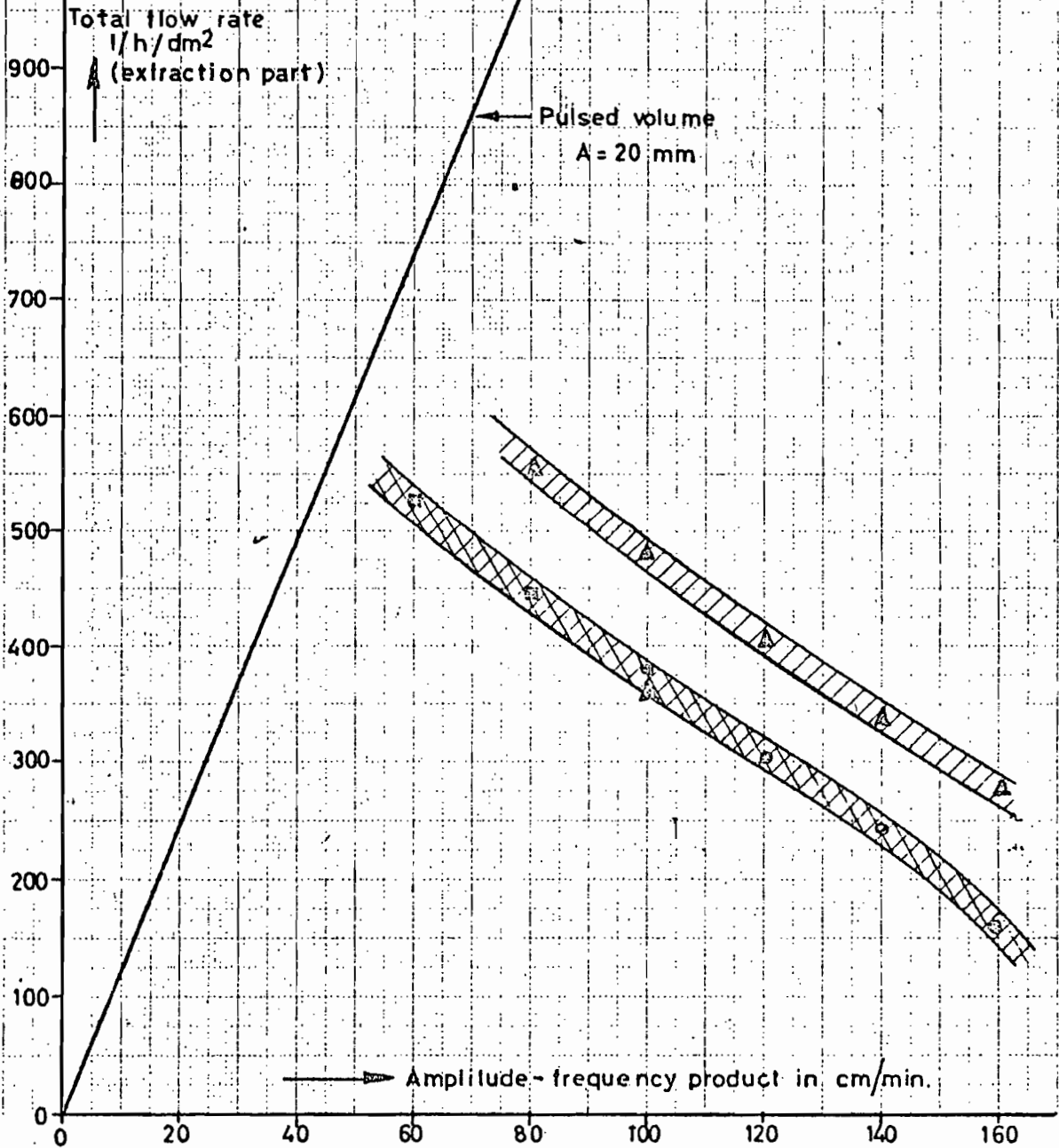
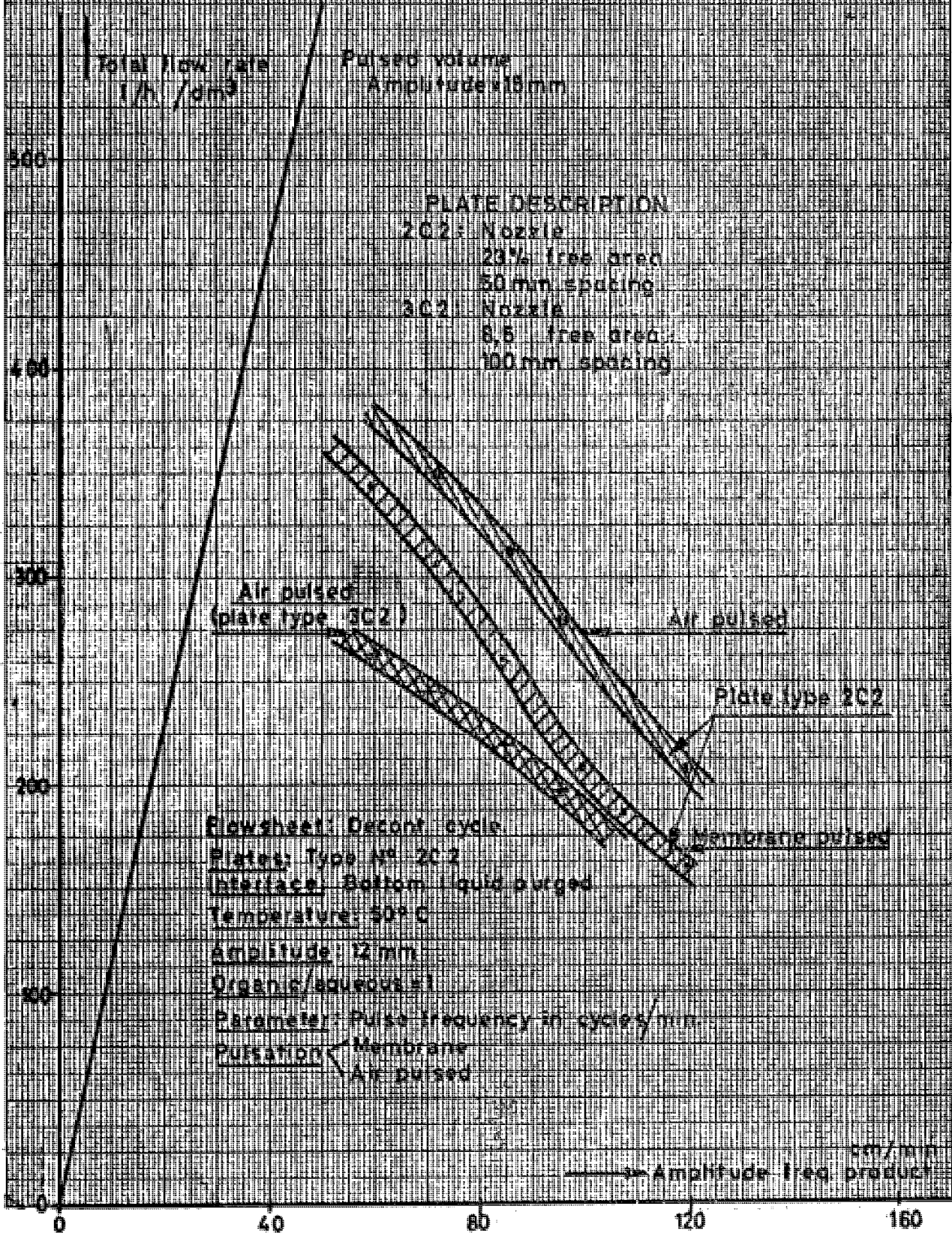


FIG. 9 FLOODING CAPACITY AS A FUNCTION OF THE AMPLITUDE FREQUENCY PRODUCT FOR THE STRIPPING COLUMN (1C)



D.2381b

Determination of the Extraction Zone

The critical mass transfer zone in an extraction unit may be determined by the fact that the temperature increases in that zone. Thermocouples were installed on the outer wall of the extraction column and were connected to a 12 pen recorder.

Using the Second Uranium Cycle flowsheet, the transfer zone in the 2D column was clearly recorded during preliminary testing. Experiments to determine the time lag between a transfer zone change and a corresponding temperature change will be made along with tests when using the Decontamination Cycle.

Scheduled Tests

Tests will be performed with the Second Uranium Cycle flowsheet, followed with the enriched uranium dilute cycle (first) flowsheet.

4.2.2 Aqueous Phase Diluent Washer

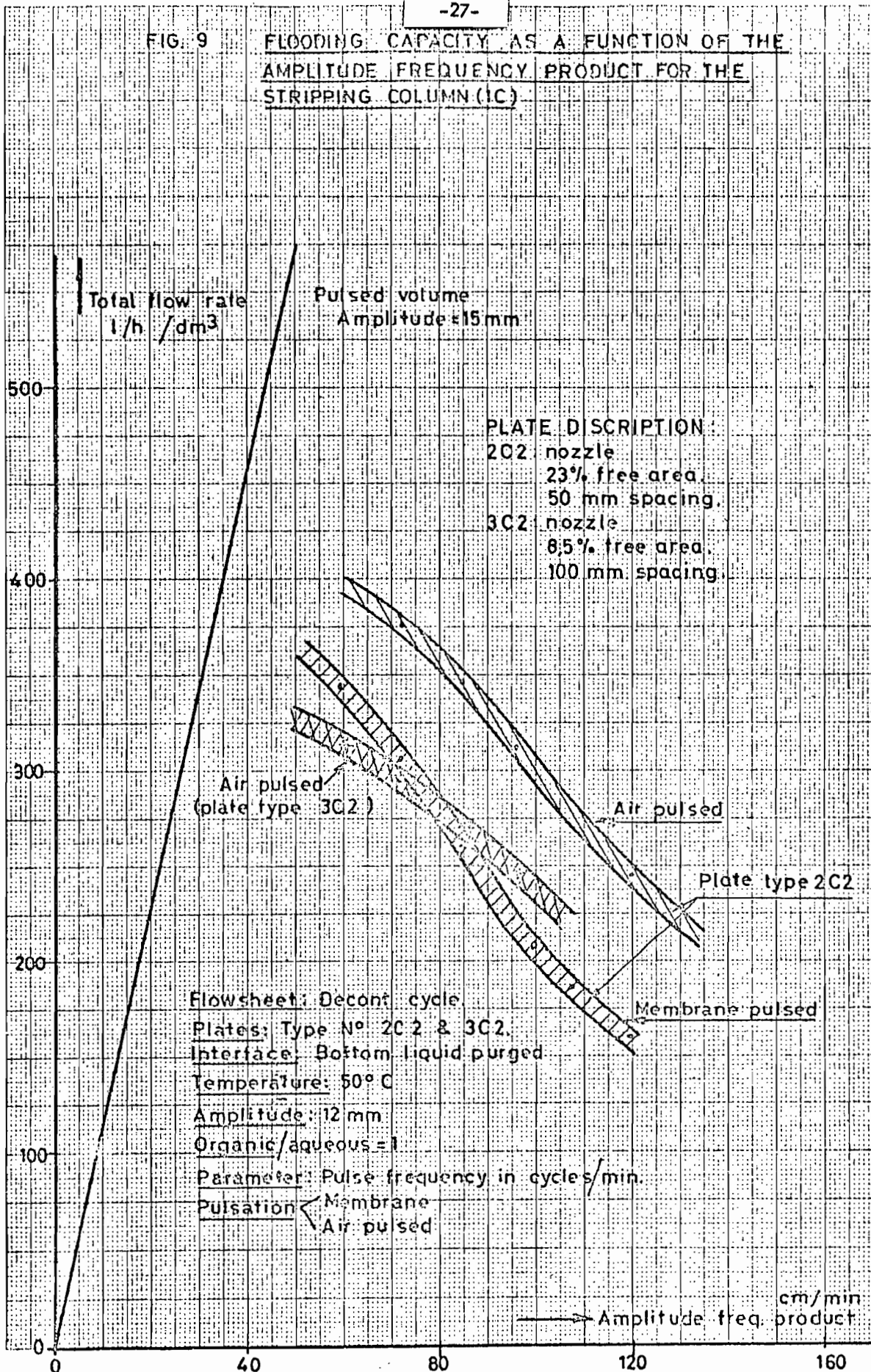
In order to decrease the amount of solvent to the evaporator, a diluent washer for the aqueous phase was tested. The unit was of the mixer-settler type and permitted mixing of both phases and recycling of the diluent from the settler to the mixer by an airlift. Flow rate conditions in the unit were, during a HAW stream washing, as follows:

HAW	---160 l/hr
Diluent (S.S.T.)	---2 l/hr
Recycled Diluent	---± 160 l/hr
<u>Air Flow</u> Diluent	---2 to 2.5

Under those conditions good mixing was achieved in the mixer, and the settling was excellent. Analyses of the in- and out-going aqueous phases showed that the total phosphorus content decreased from ± 30 mg/l to ± 5 mg/l. The solubility of TBP at 25°C in 1.5 M nitric acid is about 250 mg/l (30 mg/l P) when it has been contacted with 30% TBP/Amsco.

Runs on the proposed carbonate washer have been made. The recycled solvent, after carbonate washing, contained about 10^{-4} gU/l. Owing to the analytical detection limitations, the MBP and DBP concentrations could not be accurately determined.

FIG. 9 FLOODING CAPACITY AS A FUNCTION OF THE AMPLITUDE FREQUENCY PRODUCT FOR THE STRIPPING COLUMN (IC)



D.3453

Determination of the Extraction Zone

The critical mass transfer zone in an extraction unit may be determined by the fact that the temperature increases in that zone. Thermocouples were installed on the outer wall of the extraction column and were connected to a 12 pen recorder.

Using the Second Uranium Cycle flowsheet, the transfer zone in the 2D column was clearly recorded during preliminary testing. Experiments to determine the time lag between a transfer zone change and a corresponding temperature change will be made along with tests when using the Decontamination Cycle.

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Tests will be performed with the Second Uranium Cycle flowsheet, followed with the enriched uranium dilute cycle (first) flowsheet.

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<u>Diluent:</u>	

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Runs on the proposed carbonate washer have been made. The recycled solvent, after carbonate washing, contained about 10^{-4} gU/l. Owing to the analytical detection limitations, the MBP and DBP concentrations could not be accurately determined.

4.2.3 Air Pulsation

Air pulsation is being considered for use on the main plant columns. Initial tests on glass columns showed the need for improving the auxiliary devices used for controlling the pulse and for developing ways of amplitude detection. Three different pressure regulators have been evaluated with the result that none are considered satisfactory as received. Several mechanically operated valves are also being tested for use as airflow regulators.

Theoretical studies are being made, using USAEC Report HW-70489 as a basis, to determine the pressure drop and the amplitude in a column. Pressure drop calculations are in good agreement, but amplitude values do not fit the simplified formula given in HW-70489.

A set of curves, based on experimental data, is being prepared to summarize air pulsation data. Air consumption (Q_0) will be plotted against column amplitude (A), using pulse head pressure (pH) and air inlet time to period time ratio (Ti) as parameters. These curves will form the design bases for the plant columns and will permit compromise limits to be set.

Direct amplitude detection in the pulse tube has not been successful. Several consulting firms contacted have refused to propose a solution to the problem. Two indirect ways under study are (a) correlation of the amplitude to the air consumption by calibration, and (b) detection of the instantaneous liquid speed in the tube and integrating this speed between two consecutive inversions.

4.2.4 Sampling

The sampling system for the main plant is a modified Thorex system. Two variations are used, one in which the solution is collected in the sample bottle (Fig. 10), and the second in which an inline instrument is included in addition to the sample bottle (Fig. 11). The main features in which the Eurochemic sampling system differs from the Thorex sampler, are as follows:

- use of a single vacuum supply provided by a liquid-sealed vacuum pump
- use of diaphragms in the vacuum supply line for vacuum control
- air introduction, for vacuum regulation, into the sampling circuit through the vacuum regulator
- use of an average submergence of 40%, with the separator pot normally empty

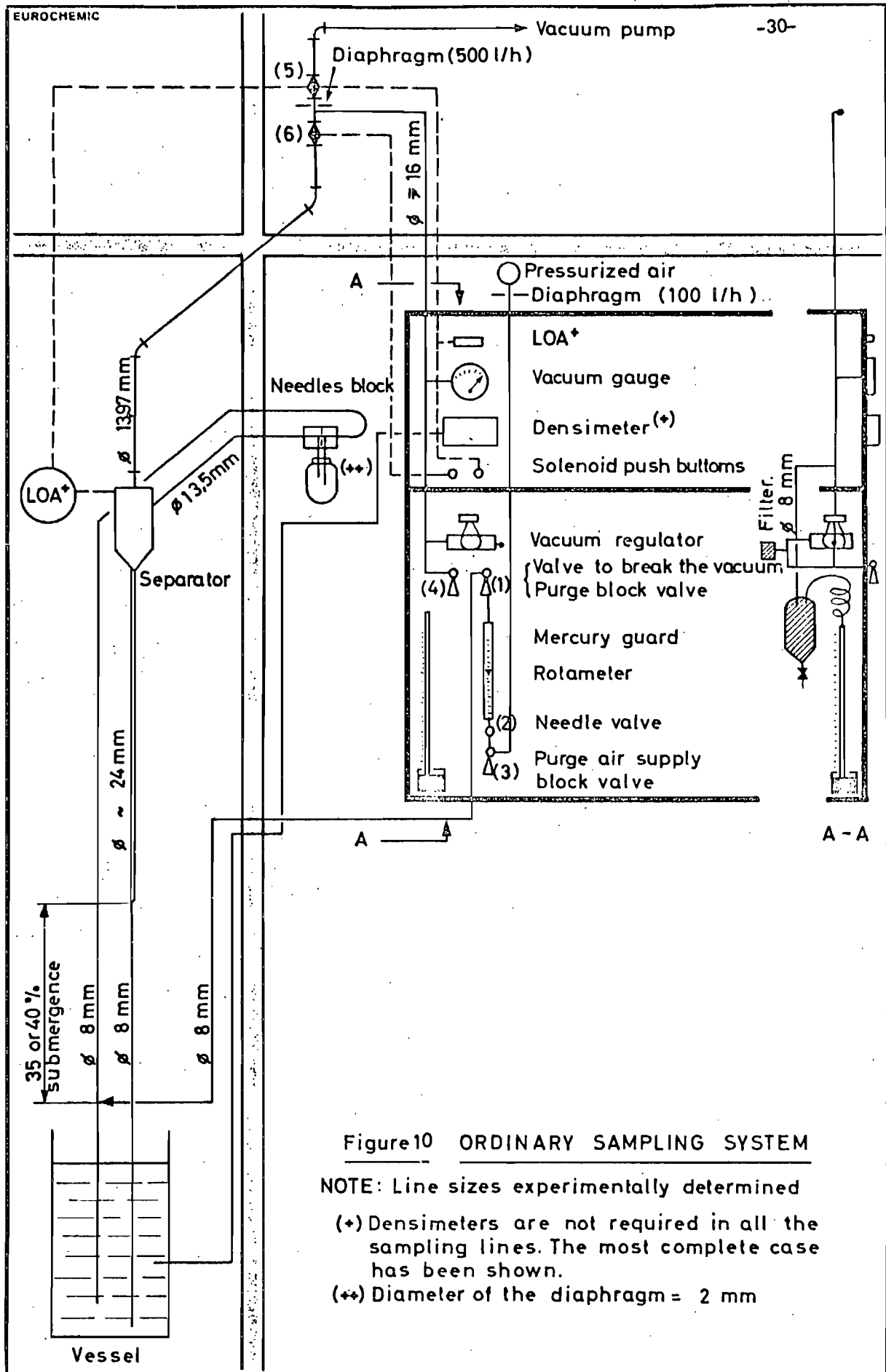


Figure 10 ORDINARY SAMPLING SYSTEM

NOTE: Line sizes experimentally determined

(+) Densimeters are not required in all the sampling lines. The most complete case has been shown.

(++) Diameter of the diaphragm = 2 mm

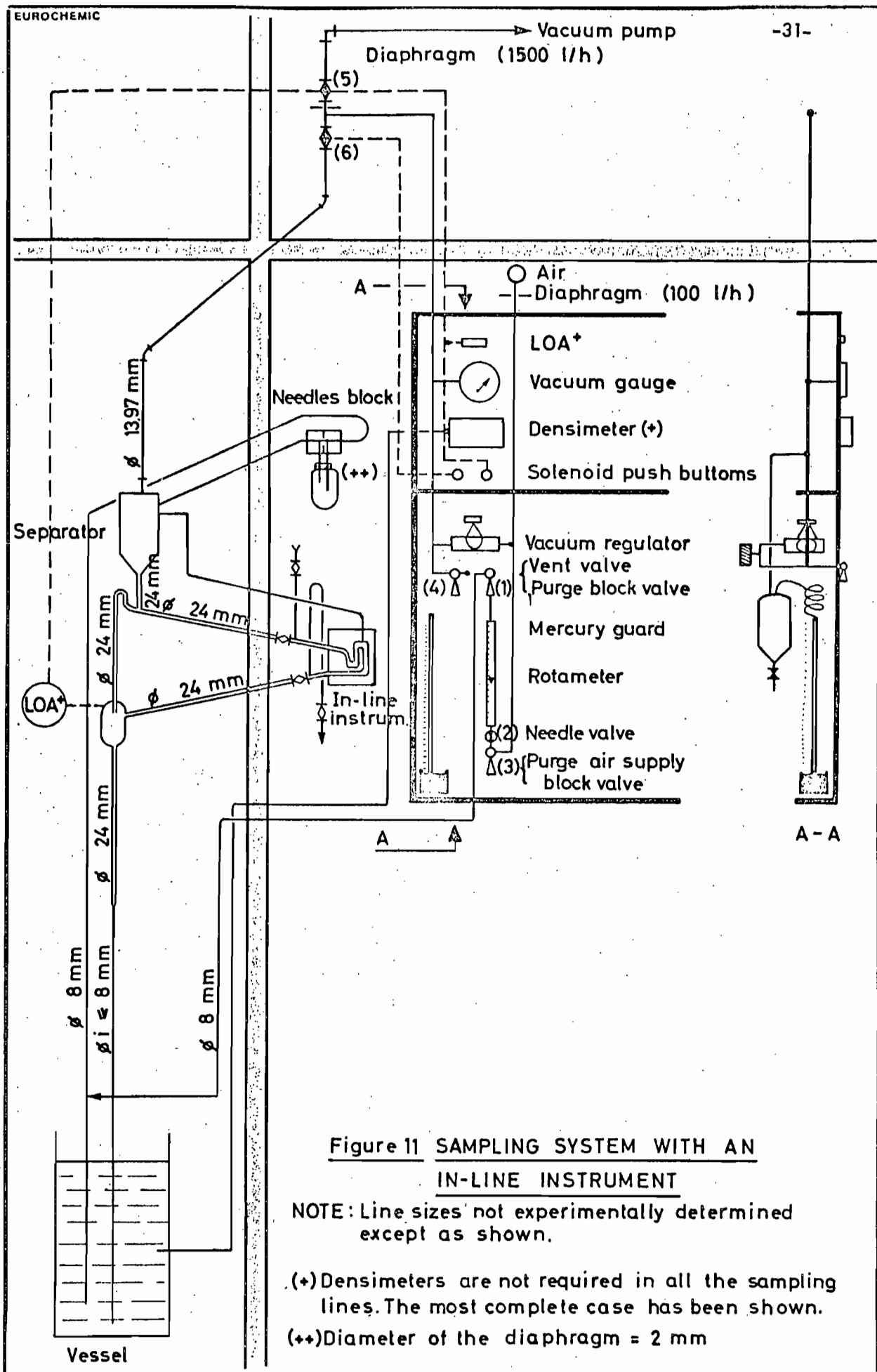


Figure 11 SAMPLING SYSTEM WITH AN IN-LINE INSTRUMENT

NOTE: Line sizes not experimentally determined except as shown.

(+) Densimeters are not required in all the sampling lines. The most complete case has been shown.

(++) Diameter of the diaphragm = 2 mm

- use of an automatic vacuum shut-off valve if liquid rises into the separator

The first variation has been pilot tested using water, kerosene, and 1 M UNH solutions. These tests have been made to evaluate the following:

- recirculation and sampling rates versus varying diaphragm orifice sizes
- entrainment of liquid into the vacuum system
- effects of uncovering the lift and return lines
- various designs of the sampling lines to overcome effects of insufficient slope
- effects of sample bottle removal during operation
- recirculation of solutions at 60°C

The following tests will be made, after which the results will be published.

- evaluation of a new designed needle block and a different type of vacuum regulator, repeating the above tests
- influence of solids
- sampler operation with the inline instrument in service
- full-scale mockup of critical in-plant systems

4.2.5 Evaporation

The Testing Station evaporator was made for concentrating the non-irradiated depleted uranium solution coming from the extraction pilot for re-use in preparing feed for extraction studies. The evaporator is simultaneously used to obtain design information for the plant intercycle evaporators.

The evaporator, a climbing film type, has a design capacity of 320 kg water/h boil-off rate. The heating surface, 14.2 m², was oversized for the testing station and prevented stable operation from being obtained. Therefore, 30 of 43 tubes (diam 32/2, length 3500 mm) were blocked with teflon stop-cocks, reducing the heating surface to 4.2 m². Following this modification, operation became stable.

Heat transfer values (k -values) of 2200-2300 kcal/h/m²/°C were obtained at the boiling point of 106°C, with 1.8 atmos. (27 psig) in the steam chest and a tube bundle submergence of 30, 40, and 50%.

The control of the evaporator was initially unsatisfactory. As originally designed, control of the steam (or part of the steam) was by the level, control of the concentrate discharge was by density, and the feed rate was kept constant. Level and density were measured with air-purged dip-tubes in the 110 mm diam downcomer. The possibility of using a density compensating level controller was not considered because of a long delay on a deviation relays and because it would require one more density dp-cell. An overflow was installed at a level corresponding to 40% submergence in the tube bundle and a part of the steam (about 25%) was changed to density control. The effect of steam entrainment on the measured density (6 - 10% reduced) is not inconvenient when known and taken into consideration. The operation of the evaporator is now very satisfactory.

Studies on the behavior of the steam stripping column has been started. The vapor enters at the bottom of the 420 mm diam column and rises counter-currently to the feed through a 800 mm high layer of Raschig rings to strip traces of TBP out of the feed. There are two sieve plates above the feed inlet to de-entrain uranium from the vapor. Demineralized water can be introduced above the top plate. Varying the water reflux rate from 25 l/hr to 0 l/hr varied the uranium concentration in the water on the two plates from about 15 mg/l to about 200 mg/l; in all cases, the condensate was found to contain about 1 mg U/l. The evaporator feed contained 80 g U/l, the concentrate, 480 g U/l, and the evaporation rates were 250 and 300 kg/h of water.

4.2.6 Steam Jets Studies

The steam jet tests were originally designed to evaluate the discharge temperature change as a control to stop the steam supply to the jet when the vessel was empty. After starting the tests, the scope was extended to include testing the possibilities of metering with a jet. Three different metering methods were considered:

- a) Metering by steam pressure control
- b) Metering by applying vacuum to the suction vessel
- c) Metering by introduction of air into the suction line

Method (a) was quickly eliminated owing to the characteristics of a steam jet. Method (b) has shown that it is possible to meter down to 58% of full flow with a reproducibility of about 3%. Method (c) has shown that it is possible to meter from full flow down to 50% of full flow with a reproducibility of about 3%.

When examining the results of the experiments (b) and (c) above, it was found that an equal temperature increase was obtained when metering a given amount by either method. This suggested that a temperature increase control could be used as a metering control. By letting the temperature increase control the introduction of air, it was believed that a stable metering could be obtained with different pressures in the suction vessel and with changes in suction height. Tests with water having temperatures from 5 - 20°C have been very promising. The operation is stable, the set point changes are quickly adjusted for, and the reproducibility seems to be better than $\pm 3\%$. These tests are being continued.

4.2.7 Slurry Detection

Experiments on slurry detection have been started to test the following three methods:

- a) liquid purged dip-tubes
- b) thermistors
- c) ultrasonics

The experiments have been performed in a glass vessel in order to enable visual inspection. The slurries have been sand-poured into water in the vessel or barium sulphate formed by adding sulphuric acid to a barium chloride solution in the vessel. Preliminary results indicate the possible use of methods (a) and (c); these tests will be continued.

4.2.8 Dissolution

The design of the pilot dissolver (prototype for the plant) was completed and ordered from C.A.F.L. (France). The dissolver will be fabricated of Uranus B6 (see Sect. 3.4), which is manufactured by C.A.F.L. The dissolver will cost about \$50,000, with the total installation costing about \$100,000. The system will be installed in the new Research Building and is scheduled for operation by June, 1963.

4.3 Analytical

In preparation for the plant analytical laboratory, development efforts are being conducted, both on the equipment and the procedures. Equipment development is principally concerned with adapting conventional equipment to remote application. Procedures are similarly being studied for accuracy and adaptability. The procedures being studied are given below:

Spectrometry Counting

The aim is directed towards absolute counting with a 4π proportional counter and determining the gamma spectra of fission product mixtures. A report covering this work is being prepared.

Cerimetric Analyses

Cerimetric analyses will be used for determination of U^{+4} , U^{+6} , and Pu in the presence of hydrazine and of hydrazine in the presence of U^{+4} and U^{+6} . Preliminary indications are that the plutonium content can be measured with a $\pm 0.5\%$ accuracy (in the mg level), that U^{+4} can be measured with an accuracy of less than 0.5% (using direct titration with Ce^{+4} solution), that U^{+6} can be measured with a ± 0.5 to 1% accuracy (by reduction of U^{+6} with Ti^{+3} and measuring the difference between total U and U^{+4}), and that hydrazine can be measured with a $\pm 1\%$ accuracy (for $\sim 0.1 M$ solutions).

Iron Determinations

Two procedures are being developed for iron determinations. In the first procedure, Ce^{+4} is being electrogenerated in the solution using a constant current coulometer and a titration cell; this method may be used for samples containing 1 to 100 μg Fe (accuracy $\pm 1\%$). In the second procedure, small amounts of iron may be determined with a $\pm 2.5\%$ accuracy in the presence of uranium and plutonium; the normal citrate medium is replaced by an 0.04 M carbonate solution and the end point is detected by a color indicator.

Uranium Separation

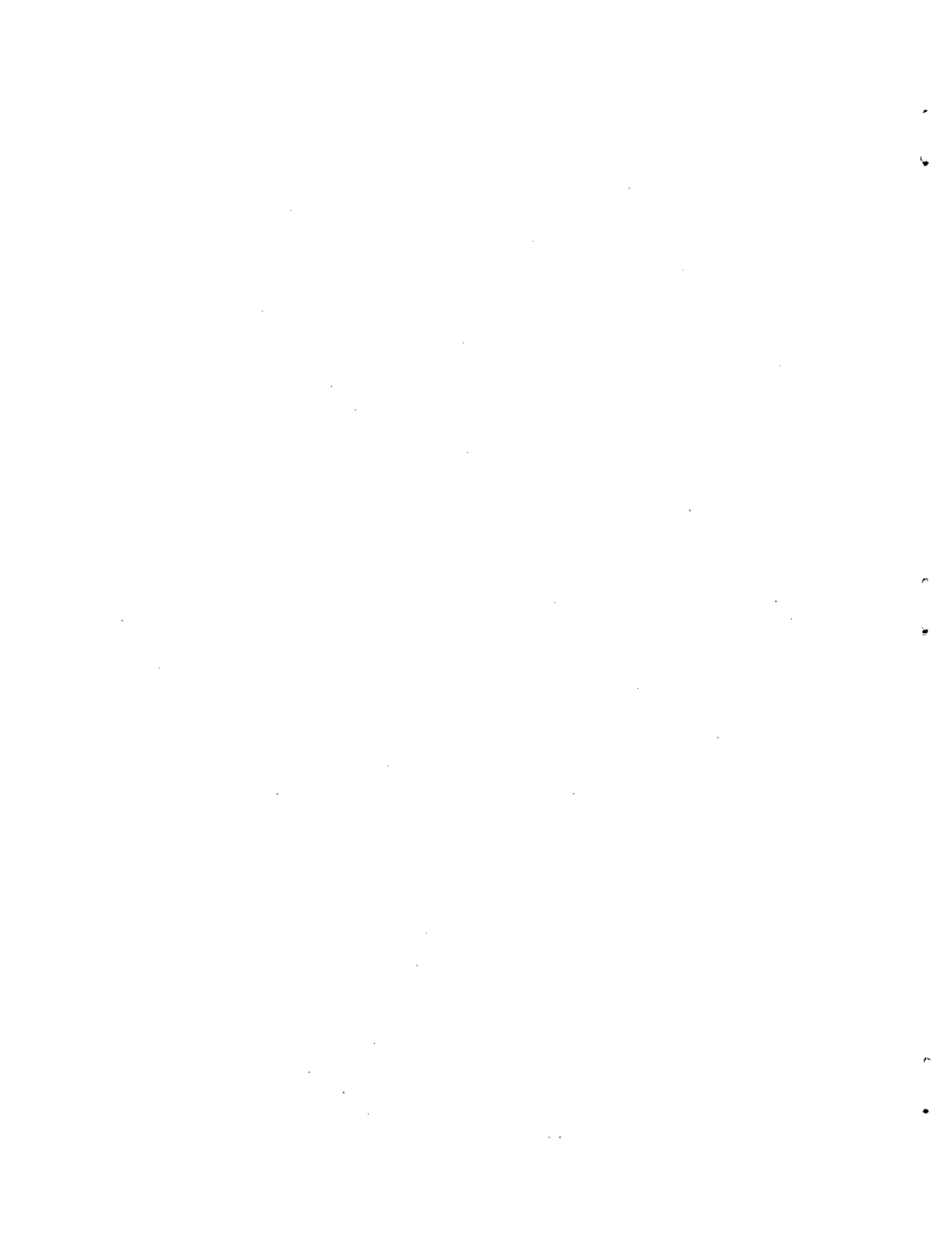
Separation of U^{+6} from stainless steel solutions have been done using the procedure described in IDO-14437; the results are in agreement. Use of the same procedure for mixtures of U^{+4} and U^{+6} gives a positive error from U^{+4} , depending on its concentration; a 50 μg U^{+4} content gives a plus 2 μg error as U^{+6} .

Coulometry

A coulometric procedure, using a platinum cell, is being tested for direct plutonium or iron analyses (without prior separation) in the feed solution. Preliminary results indicate a $\pm 1\%$ accuracy for 5 mg of iron.

X-Ray Analyses

Silver K alpha X-rays absorption by uranium is being tested for uranium analyses in the 10 to 400 g/l range. The analyses time for a 10 g U/l solution is about 1.5 min (includes only instrument use time). Effects of interfering ions have been determined as follows:



<u>Interfering Ion</u>	<u>Apparent U Conc., g/l</u>
100% TBP	6.0
3 M HNO ₃	0.5
6 M HNO ₃	1.0
3 M H ₂ SO ₄	4.0
6 M H ₂ SO ₄	8.0
10 g Al/l	0.002
5 g Mg/l	0.001
1 g Fe/l	< 0.001
50 g SS/l	5.0
1 g FP/l (simulated with Ba and Sr)	0.001
5 g Zr/l	2.0

The results of this work will be published soon.

4.4 Instrumentation

An inline-instrumentation working group has been formed to provide coordination of the development effort. The group has four permanent members (representing the Instrument, the Analytical Chemistry, and the Testing Station sections) and four consulting members. Initially, the group will emphasize development on currently proposed inline-instrumentation; these include gamma, pH, conductivity, uranium, and plutonium.

Instrument development has been somewhat curtailed during the past several months owing to the move to the General Services building. The following areas are now being investigated.

Conductivity Measurements

A transistorized circuit conductivity instrument has been designed for inline application. The instrument, with a range of 2 to 0.02 m hrs, has been laboratory tested and a final instrument built. Measurements on simulated process solutions will be made to determine accuracy and to evaluate temperature compensation circuits.

Density by Beta Absorption

Density measurement tests, using beta absorption, are being made. Some difficulties have been encountered with the ionization chambers. A series of tests have been completed using NaNO₃ solutions at constant temperature. A density change of less than 1% can be detected and recorded with good reproducibility. An extended six-day run with water also showed the instrument to

be stable; however, the liquid flow must be kept constant, as small flow variations gave large density indication changes. Preliminary tests have been made to determine temperature effects. A two-degree temperature increase gives an 0.05% change in the recorded density.

Dip-Tube Tests

Tests are being completed to determine the influence of air flow and tube position on reading precision. The results of these tests will be published in a Eurochemic report.

4.5 Health and Safety

Preliminary hazard evaluation reports are being prepared for the various facilities. These evaluations are being discussed separately with an unofficial contact commission representing the Belgian, Dutch, and Euratom Health Authorities, pending establishment of the Belgium law. At present, four volumes have been prepared covering a general description of the Eurochemic site, waste pipelines, the fuel reception and storage building, and the high level waste plant. After preparation and review of the remaining volumes, the hazards evaluation reports will be revised and issued for formal submission.

5.0 TECHNICAL ASSISTANCE

5.1 USAEC Associated Visits

The following people, associated with the atomic energy program in the U.S., visited Eurochemic.

July 19, 20, 23 - E. C. Miller, ORNL, spent three days at Eurochemic discussing materials of construction, fabrication control, and corrosion. This visit followed Mr. Miller's trip to Russia, where he was one of five specialists representing the United States in the field of equipment fabrication.

October 18 and 19 - Following the Vienna, Austria, Symposium on the 'Treatment and Storage of High-Level Radioactive Wastes', eight US participants visited the CEN and Eurochemic.

W. G. Belter and W. H. Regan of the USAEC

R. Alleman, A. M. Platt, and R. Tomlinson of HAPO

J. A. McBride and J. A. Buckham of ICPP

J. M. Holmes of ORNL

November 11, 1962 - Dixon Hoyle and E. W. Rebol, Division of International Affairs, USAEC, spent one day discussing problems relative to Eurochemic processing of US-owned fuels. This visit was of particular help to Eurochemic, as it clarified several areas of uncertainty.

September, 1962 - Paul Amaury, head of the Eurochemic Process Division, spent several weeks in the US visiting the AEC Headquarters, HAPO, ICPP, and ORNL.

December 3 and 4 - T. J. Barendregt, Technical Director, visited the Division of International Affairs, USAEC, to discuss problems associated with Eurochemic's processing of US-owned fuels. While in Washington, he also visited Nuclear Fuels Services, Inc., to discuss problems of mutual interest.

5.2 Visits to European Sites

The US advisor attended the symposium for 'Treatment and Storage of High Level Radioactive Wastes', held in Vienna, Austria, and visited the following European atomic energy installations:

Studsvik, Sweden
Kjeller, Norway
Karlsruhe and Kahl, Germany
Saclay, France

These trips were interesting and educational. In general, the visits to the various sites included a thorough tour of the area and their facilities. A brief summary of the pertinent facts obtained at each site is given below.

Studsvik, Sweden

The Nuclear Energy Research Center is located at Studsvik and is operated by the Atomic Energy Company of Sweden. Studsvik is intended to become the research and development center for the peaceful use and application of atomic energy in Sweden. The principal facilities now in operation at Studsvik include a 30 mw material testing and research reactor (R2), a zero power reactor (RO), a low power research reactor (R2-0) contained in the same pool as the R2 reactor, a laboratory for active metallurgy, an isotope preparation facility, a laboratory for radiation protection and waste disposal and a 5.5 Mev van de Graaff generator. Additional facilities being designed or under construction include a fast zero-power reactor (FR-0), a hot chemistry research laboratory, and a thermal and mechanical laboratory.

The Atomic Energy Company is owned jointly by the Swedish Government (4/7) and private industries. Headquarters are in Stockholm, along with the first research reactor (R1), the physics and chemistry laboratories, a refinery plant, and a fuel element factory.

The Studsvik Center has a capital investment of about 42.5 million dollars and an annual operating budget of nine million dollars. About 700 people are now employed at Studsvik, and this will increase to 900 by 1964 or 1965.

The Swedish atomic energy program is directed primarily to the development of a reactor system suited to Sweden's requirements and compatible to the capacities of Sweden's manufacturing industry. It is expected that about 4000 Mwe, or one-third of the projected increased use of electrical power, will have to be generated by reactors by 1970. Therefore, the principal effort is on heavy-water reactors designed for high burnup and low fuel costs. The cost of the fuel and for reprocessing are not now included in power cost calculations. For this reason, no reprocessing research is being done; such research will start after completion of the hot chemistry research laboratory. The currently favored fuel is UO₂ canned in Zircaloy, and this fuel will be used in the first prototype power reactor, R3, now under construction. (This reactor is designed for 55 Mw_t and 10 Mwe and is being constructed at Agesta, which is near Stockholm).

Kjeller, Norway

The Institutt for Atomenergi (IFA) at Kjeller, Norway, is an independent foundation governed by a Board of Directors. The Institute is financed by the Norwegian government through the Ministry of Industry. IFA is actively participating with OECD on the Dragon and Halden reactor project and Eurochemic. The Dragon project is principally sponsored by OECD, whereas the Halden project is principally sponsored by IFA.

Facilities in operation at Kjeller include the zero energy Nora, the 450 kw heavy water reactor Jeep I, a reprocessing pilot plant, a metallurgical laboratory, an isotope laboratory, a waste processing building, and a Netherlands'-Norwegian Reactor School. A new 2 Mw research reactor, Jeep II, is under construction.

A joint research program between Norway and the IAEA is in progress with the NORA reactor. A co-ordinating committee supervises the program, which is scheduled to last until 1964. The initial fuel charge was provided by the USAEC (1000 Savannah fuel stringers). The second charge was elements from the Halden project second charge and permitted important data to be obtained prior to loading the Halden reactor.

Considerable work is in progress, as a joint Netherlands'-Norwegian project, in research on fuel reprocessing. A reprocessing pilot plant was put into operation in 1961. After about one year of operation, the pilot plant was decontaminated and is now being modified. Parts of the Eurochemic extraction flowsheet will be tested using 100 days decayed Jeep I fuel. These pilot runs will be made under various conditions to evaluate the decontamination factors for the principal fission products. Laboratory-scale investigations on the chemistry of uranium, plutonium, and fission products are being conducted to improve separation methods by liquid-liquid extraction, ion-exchange, and adsorption.

Other research activities are being conducted on new analytical methods (including routine analyses of heavy water), reactor materials, fuel elements, high temperature corrosion of aluminum, and reactor physics.

Karlsruhe and Kahl, Germany

A 55 Mw_{th} power reactor, using Zircaloy clad UO₂ fuel, has been constructed at Kahl, Germany. The reactor was purchased from the General Electric Company and was put into operation in 1960. The reactor was purchased with a guaranteed fuel burnup of 8,000 Mwd/ton. The reactor site contains associated service facilities in addition to the reactor.

The Nuclear Research Center at Karlsruhe, Germany, is operated jointly by the German government and a group of German industrial companies. The Center was started in 1956 and has increased in size to 1600 people. The Center includes a school for reactor technology, a cyclotron, a 25 Mw_{th} research reactor (FR2), a low power reactor (Argonaut), a laboratory for nuclear physics and reactor technology, a reactor component testing facility, and facilities for radiation application, electronic development, radiobiology, radiochemistry, chemical technology, and experimental nuclear physics. Facilities under construction or being designed include a 50 Mw_e (200 Mw_{th}) multipurpose research reactor, a hot process chemistry building, hot cells, a transuranium laboratory, and isotope separation. The hot cells are being designed to handle mixed fission product sources of 100,000 curies. The multipurpose research reactor will be a D₂O moderated pressurized-water type fueled with natural UO₂ in ZrO₂ clad.

Saclay, France

The visit to the Saclay center was in connection with corrosion experiments (see Sect. 3.4) being conducted for Eurochemic. Inspection of other facilities was not possible.

5.3 Reports

The following reports have been issued by Eurochemic during this period:

Technical Reports (Available for Limited External Distribution)

ETR-

- 139 "Study of the Dynamic Behavior of Thermowells (IV)" by J. Challe
- 140* "Tests for the Design of the Eurochemic Hot Waste Evaporator (II)"
by A. Redon, F. Marcus, and L. A. Nøjd
- 141 "Investigation at Kjeller of the Decontamination Factors of the
Eurochemic First Extraction Cycle Flowsheet (II)" by E. Detilleux,
E. Lopez-Menchero, and J. Centeno
- 142* "Experiments Carried out in the Eurochemic Extraction-Column Pilot
Plant Concerning the Co-Decontamination Cycle Flowsheet (II)" by
R. De Witte, J. Klitgaard, and A. Redon
- 143* "Some Solvent Extraction Equilibrium Data for the Processing of
Highly Enriched Uranium/Aluminum Fuels (II)" by J. Centeno
and W. Drent
- 144* "Gamma Monitor for In-Line Instrumentation (II)" by L. Svansson
and Daneels

Internal Reports (Distribution Restricted to the Company)

EIR- (I)

- 85 "EAP Trip Report - USAEC" by E. M. Shank
- 86 "Enriched Uranium-Aluminum Processing in the Eurochemic Plant:
Evaluation Studies" by W. Schüller and E. M. Shank
- 87 "Interim Report on the Controlled Potential Coulometric Determina-
tion of Uranium" by B. Edwall, L. Humblet, and R. Revil
- 88 "Comparison of Investment and Operating Cost for Nine Alterna-
tives for MTR- and Breeder-Fuel Processing at the Eurochemic
Plant" by W. Schüller and E. M. Shank

* In reproduction.

() Indicates distribution category.

EIR-(Cont'd)

- 89 "Essais De Reception De Detecteur De Radiation (Suite)" by L. Svansson and V. Willems
- 90* "Purification Ultime du Plutonium par Extraction a la TLA and Precipitation Directe sur la Phase Organique" by E. Detilleux, G. Rolandi, et al.

5.4 Other

The third US technical advisor, E. M. Shank of ORNL, arrived at Eurochemic in July 1963. Mr. Shank's appointment is for about two years.

Coordination of the assistance program is done by the advisor through ORNL. Requests for assistance are made directly to the USAEC sites concerned, and the information supplied by the sites is sent to Eurochemic via ORNL. A total of 24 request letters (9 to ORNL, 5 to the USAEC, 4 each to ICPP and HAPO, and 1 each to SRP and ANL), and 13 requests for documents were issued. A total of 326 USAEC-originated documents and 10 miscellaneous items were sent to Eurochemic via 14 transmittal letters (91 through 104). The 55 Eurochemic-originated documents received during the last report period are being reproduced and distributed according to the USAEC-Eurochemic document exchange agreement. A total of 42 reports, written in French, have been translated, reproduced, and distributed.

A Eurochemic-ENEA sponsored symposium has been scheduled for April 23 through 26, 1963. This symposium, to be held at Brussels, Belgium, will be on aqueous reprocessing chemistry for nuclear fuels. The purpose will be to compare developments in the European continent with recent development in the US and the UK. The four-day meeting will be divided as follows:

1. Present understanding of chemical mechanisms of various extraction methods and an evaluation of the experience.
2. Eurochemic research and development efforts and results.
3. Visit to the Eurochemic installation.
- 4a. Review of the status of aqueous reprocessing and comparison with non-aqueous and pyrometallurgical methods.
- 4b. Present and future role of reprocessing in the fuel cycle, followed by a panel discussion.

6.0 APPENDICES

6.1 Bibliography

Reference Reports on the Eurochemic Assistance Program:

ORNL-CF-58-12-124, "US AEC Assistance Program to the Eurochemic Company," Mol, Belgium

ORNL-CF-59-5-5, "EAP: Status Report as of April 1959"

ORNL-CF-59-10-61, "EAP: Status Report for April through September 1959"

ORNL-CF-60-2-72, "EAP: Progress Report for October through December 1959"

ORNL-CF-60-8-2, "EAP: Progress Report for January through June 1960"

ORNL-CF-61-8-68, "EAP: Progress Report for July 1960 through June 1961"

ORNL-TM-246, "EAP: Progress Report for July 1961 through June 1962"

6.2 Organization Charts

The principal sections for the Research Department (Fig. 12) and the Technical Department (Fig. 13) are given. Every person is not shown, however.

Director - R. Rometsch (Switzerland)

Technical Secretary - R. Brooks (Great Britain)

Documentation - A. Norström (Sweden)

Health and Safety - W. Hunzinger (Switzerland)

Applied Chemistry - E. Detilleux (Belgium)

Head-End - J. Van Caeneghem (Belgium)

Extraction - J. Centeno (Spain)

Tail-End - G. Rolandi (Italy)

Maintenance - C. de Raikem (Belgium)

Testing Station - A. Redon (France)

Extraction - R. De Witte (Belgium)

Dissolution - H. Backström (Sweden)

Air Pulsation - A. Hall (Italy)

Chemical Engineering - J. Klitgaard (Denmark)

Analytical Chemistry - B. Edwall (Sweden)

Equipment - H. Moeken (Holland)

Spectrometry and Counting - G. Hannestad (Norway)

Current Analyses - P. Hansen (Germany)

Coulometrie - L. Humblet (Belgium)

Physical Chemistry - E. Lopez-Menchero (Spain)

Fig. 12. Eurochemic Research Department Organization (December 31, 1962).

Director - T. J. Barendregt (Holland)

Technical Advisor - E. M. Shank (USA)

Analytical Laboratory - W. Heinz (Germany)

Plant Process - P. Amaury (France)

Criticality and Shielding - W. Schüller (Germany)

Head-End - J. Frémann (France)

Extraction, Waste, Ventilation - A. Cabella (Italy)

Solvent Recovery, Rework, Sampling - J. Clement (Spain)

Utilities, Product Storage, Inactive Solutions - P. Fischer (Austria)

Transportation, Storage, Waste - F. Marcus (Denmark)

Transportation - J. Asyee (Holland)

Reception & Storage - H. Dreissigacker (Germany)

Waste - S. Thorstensen (Norway) and N. Omay (Turkey)

General Services - L. Nøjd (Sweden)

Civil Engineering - J. Jacobsen (Denmark)

Instrumentation - A. Mongon (France)

Equipment - H. Dreissigacker*

Drawing Office - N. Frankignoul* (Belgium)

Workshop & Maintenance - N. Frankignoul*

Instrumentation Development - A. Mongon

Electronic - L. Svansson (Sweden)

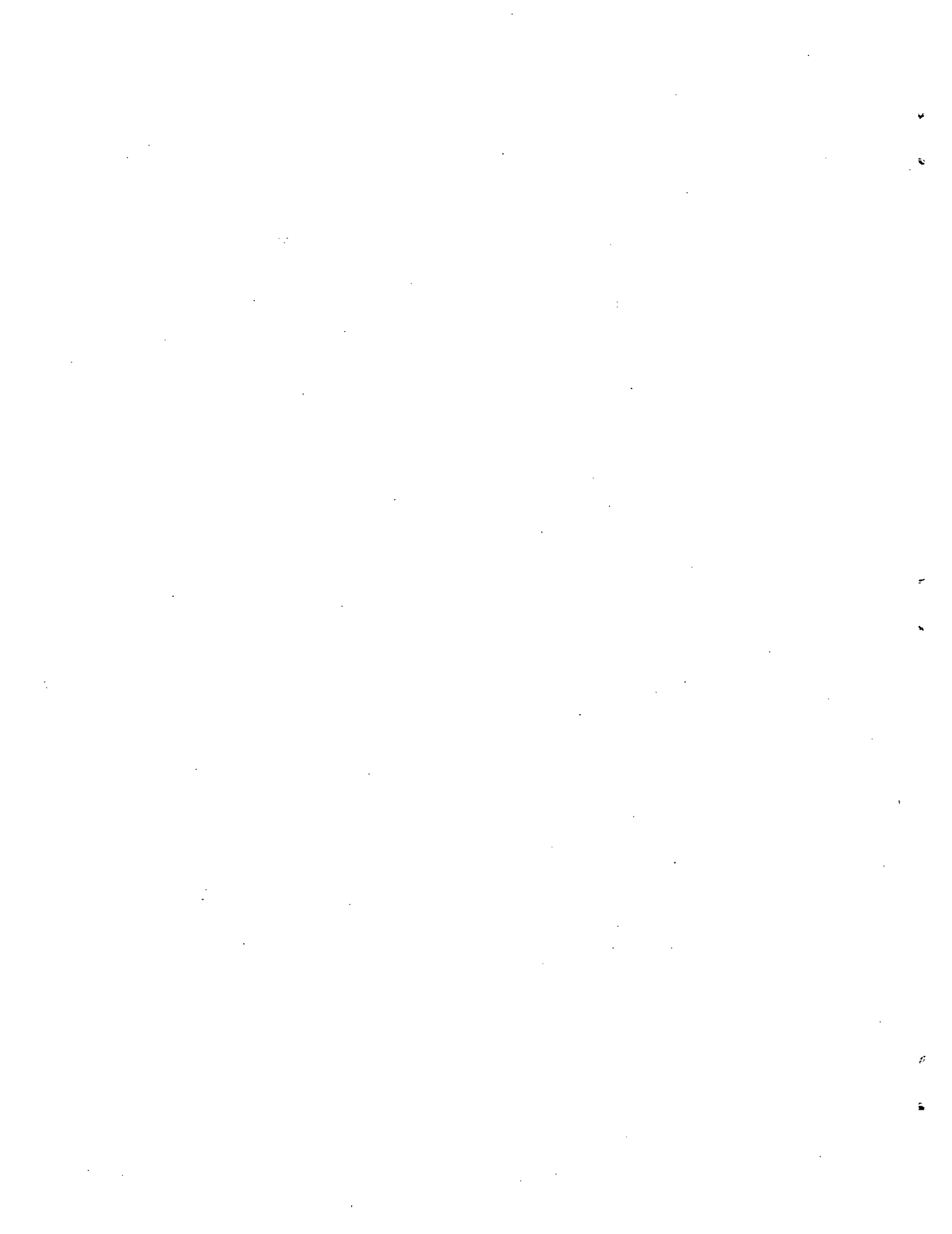
Instrumentation - J. Challe (Belgium)

* Effective January 1, 1963.

Fig. 13. Eurochemic Technical Department Organization (December 31, 1962).

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